E8A

Vol. 31, Part 2. JUNE, 1960.

THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

COMMONWEALTH INST. OF TECHNOLOGY LIBRARY
5 OCT 1960
As.94A

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakele,
Ceylon.

NOTICES

General.—The laboratories of the Institute are situated at St Coombs Estate, Talawakele, and letters and enquiries should be addressed to the Director, Tea Research Institute, Talawakele. Telegraphic address: Research, Talawakele; Telephone: Talawakele 44 (Private Exchange).

It is particularly requested that letters should not be addressed to officers by name. Specimens and other consignments sent by rail should be forwarded to Talawakele Station, c/o Messrs M. Y. Hemachandra & Co., Ltd., Forwarding Agents. *Carriage should be pre-paid.*

Low-country estates should address their correspondence and enquiries to the Low-Country Adviser, T.R.I., "Kalindi," Riverside Road, Ratnapura.

Visitors' Days.—The *second* and *last* Wednesdays in each month have been set aside for Visitors' Days at St Coombs Estate and also at the T.R.I. Sub-Station, Gonakelle Estate, Passara, when it is hoped that those interested will visit the stations.

Guest House.—The house formerly used for guests is now an officer's residence and it is regretted that, for the time being, no Guest House facilities are available. Those visiting the Institute or the Estate on business, who are unable to arrange accommodation in the neighbourhood, should seek the help of the Director.

Publications.—The Tea Quarterly, Bulletins (New Series), Pamphlets, and Annual Reports, published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over ten acres in extent and to estate agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St Coombs, Talawakele.

Other persons can obtain the publications of the Institute on application to the Director, the post-free subscription being fifteen rupees per annum for persons resident in Ceylon or India and £1–5–0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs 2.50 or 4*s*. Indian cheques should have four annas added to cover commission.

THE TEA QUARTERLY

Vol. 31 June, 1960 Part 2

BOARD OF CONTROL

of the

TEA RESEARCH INSTITUTE OF CEYLON

as at 25th April, 1960

Chairman

Mr F. Amarasuriya

Secretary

Mr H. J. Balmond

Appointed by the Planters' Association of Ceylon:—

Mr R. C. Scott, C.B.E.
Mr W. H. W. Coultas
Mr N. M. Sanders

Appointed by the Agency Section, Planters' Association of Ceylon:—

Mr R. M. Macintyre
Mr R. J. Gilmour
Mr R. D. Wedd

Appointed by the Low-Country Products Association:—

Mr J. L. D. Peiris
Mr E. Jayawickreme
Mr F. Amarasuriya

Representing the Smallholders:—

Mr D. E. Hettiarachchi, J.P., U.M.
Senator Reginald Perera

Representing the House of Representatives:—

Vacant

Ex-Officio Members:—

Mr H. E. Peries, O.B.E., C.C.S.,
representing the Hon. the Minister of Finance.
The Director of Agriculture (Dr M. F. Chandraratna, M.B.E.)
Mr H. Creighton,
Chairman, Planters' Association of Ceylon.
Mr G. I. de Glanville,
Chairman, Agency Section, Planters' Association of Ceylon.
Mr E Muttukumaru, J.P.
Chairman, Low-Country Products Association.
The Tea Controller (Mr B. Mahadeva, C.C.S.)
The Director (Dr D. L. Gunn, C.B.E.)

STAFF

as at 25th April, 1960

Director	...	D. L. Gunn, C.B.E., D.Sc. (Wales), Ph.D. (Birm.)
Agricultural Chemistry		
Agricultural Chemist	...	J. A. H. Tolhurst, B.Sc. (Reading)
Research Assistant	...	K. P. G. S. W. Karunaratne, B.Sc. (Cey.)
Senior Technical Assistants	...	E. N. Perera
		V. Mendis
Assistants	...	S. Samarasingham
		T. C. Z. Jayman
		E. O. Steuart
		A. H. R. Balthazaar
Biochemistry		
Biochemist	...	*Vacant*
Research Assistant	...	M. S. Ramaswamy, B.Sc. (Mysore,) A.R.I.C., A.I.I.Sc.
Assistants	...	T. S. Nathan
		B. P. M. Perera
Technology		
Technologist	...	E. L. Keegel
Research Assistant	...	D. Kirtisinghe, B.Sc. (Cey.)
Assistants	...	K. Sothisrihari
		L. S. Weragoda
Plant Physiology		
Plant Physiologist	...	T. Visser, Dr, Ir (Wageningen)
Vegetative Propagation Officer	...	F. H. Kehl
Research Assistant	...	K. L. D. Ameratunga, M.Sc. (Mysore)
Senior Technical Assistant	...	M. Piyasena
Assistants	...	A. C. B. Pethiyagoda
		S. Nagarajah, B.Sc. (Cey.)
		N. de S. Jayasundere
		A. R. M. Hassim
		N. S. Rajendram, B.Sc. (Madras)
		D. D. Kroon
		H. B. Ratnayake
		J. I. H. Bandaranayake
		H. R. Solomon
Plant Breeding		
Plant Breeder	...	*Vacant*
Plant Pathology		
Plant Pathologist	...	D. Mulder, Nat. Phil. Dr (Amsterdam)
Research Assistants	...	*N. Shanmuganathan, B.Sc. (Cey.)
		R. L. de Silva, B.Sc. (Cey.)
Assistants	...	W. Redlich, B.Sc. (Cey.)
		P. V. Arulpragasam, B.Sc. (Madras)
		S. Murugiah
Entomology		
Entomologist	...	J. E. Cranham, B.A. (Cantab.), D.I.C.
Entomologist, Special Research	...	E. Judenko, Ph.D. (Cracow)
Research Assistant	...	*D. Calnaido, B.Sc. (Cey.)
Senior Technical Assistant	...	D. J. W. Ranaweera
Assistants	...	E. F. W. Fernando
		C. Shanmugam
		G. B. Rajapakse

*Working overseas

Nematology

Nematologist	...	M. T. Hutchinson, B.Sc., Ph.D. (Rutgers)
Research Assistant	...	R. A. Jayatilleke, B.Sc. (Cey.)
Assistants	...	*M. K. Vythilingam
		P. A. John

Agronomy

Chief Agronomist	...	*Vacant*

Statistics

Statistician	...	*Vacant*

Low-Country Advisory Service

Scientific Adviser	...	A. W. R. Joachim, O.B.E., B.Sc., Ph.D. (Lond.), F.R.I.C., Dip. Agric. (Cantab.)
Assistants	...	A. E. T. Ellawella
		U. L. M. de Silva

Advisory Service (St. Coombs)

Chief Advisory Officer	...	C. B. Foster-Barham, M.A. (Cantab.)
Senior Technical Assistant	...	L. M. de W. Tillekeratne, B.Sc. (Cey.)
Assistant	...	*J. V. Sabanayagam
Photographer	...	D. J. M. Hettiarachi

Engineering

Clerk of Works	...	O. J. Fernando
Works Clerk	...	R. A. Daniel
Storekeeper	...	I. P. Dissanayake
Electricians	...	W. R. Solomon
		K. M. L. B. Fernando
Mechanics	...	D. A. S. Opatha
		K. S. Vadivelu

St. Coombs Estate

Superintendent	...	A. L. Elias
Tea Maker	...	A. T. Fernando
Apothecary	...	S. P. de Silva
Office Staff	...	P. E. de Silva
		G. L. A. Thomas
		M. R. K. Gabriel
		V. Kodagoda

Administration

Chief Administrative Officer	...	H. J. Balmond, B.A. (Lond.)
Administrative Secretary	...	G. A. D. Kehl
Personal Assistant to the Director		A. C. Perera
Assistant Secretary	...	C. Kirthiratne, F.C.C.S. (Lond.)
Accounting Assistant	...	A. H. B. Dias
Stenographers	...	F. G. de Sielvie
		D. C. W. T. Amerasinghe
		G. A. S. Gunasinghe
Accounts Clerks	...	R. I. Pereira
		W. P. Chandrasekera
		P. N. Costa
		W. J. Samuel
		M. B. Palies
Filing Clerk	...	E. Navaratne
Library Clerk	...	V. A. Rangala

Visiting Agent—St. Coombs Estate
A. Mackie

---

* Working overseas

EDITORIAL COMMENT

Fish-leaf Plucking

Dr Visser's article on plucking can be of considerable cash value to the industry. For those who do not wish to wend their way along the intricate paths by which he has reached his conclusions, a discussion is provided, starting on page 47. A still more pithy summary is given on page 50. If pluckers can be trained to distinguish between normal plucking, which leaves a young leaf behind on the shoot (*arumbu*) and fish-leaf plucking (*kuttelai*), which does not, and to act on that distinction when told to do so, considerable gains in crop can be got. Fish-leaf plucking might be valuable in many places, by judiciously applying it in the dry season and so tending to level off yield with the rush season; and it can give big gains from tea that is to be uprooted within, say, four years. Fish-leaf plucking is in no sense coarse plucking — on the contrary, it is hard and fine. Methods of assessing quality of made tea are too rough and ready to use for comparing the results of normal and fish-leaf plucking, and it is quite probable that there is no difference. It is realised that the problems of control posed by intermittent fish-leaf plucking are not inconsiderable, but of course it is easy to see at a glance whether a bush is being regularly plucked normally or down to the fish-leaf.

Cheap Planting

Mr Watt describes his methods of vegetative propagation at Endane. They are unorthodox, especially in omitting any planting into baskets or pots, and in planting straight from the cuttings beds to the field. It is easy to see why this method should *not* work but it *is* working at Endane, and it is saving a lot of money. It is not expected to be so successful elsewhere, especially in Uva and the mid-country, but it might come off in up-country estates.

Economy in Blister-blight Spraying

Dr Mulder and Mr R. L. de Silva have now given an account of the estate trials of reducing the frequency of blister-blight spraying by using sunshine records to forecast when spraying will be unnecessary. Some estates are so prone to attack and others are attacked so seldom that forecasting will not help them much; but for the middle group, great savings in expense can be made by using this system. Dr Visser's account of the scientific background of the work is to be submitted to an international scientific journal.

Visit to Tocklai

Dr Mulder's account of his visit to Tocklai provides some interesting comparisons — and contrasts — with the situation in Ceylon. The work on tipping level may be relevant to this country.

Shot-hole Borer

Dr Judenko reports on some preliminary attempts to discover immunity, resistance, or tolerance to Shot-hole Borer in clones. No immune clone has been

found, but TRI 2023, which is in any case a favourite in the low country, may be resistant. The clonal testing plots now being laid down should give more reliable evidence. Reports of apparently immune bushes of seedling tea are still required.

Copper

Mr Ramaswamy, in his account of copper in tea, shows that it is an essential part of any leaf that is to make good tea, but there is also extraneous copper from spraying. This is put into perspective, in relation to amounts of copper in a variety of foods.

Letters to the Editor

It is sometimes said that replanting by vegetative propagation is impeded by lack of knowledge and experience of the techniques. For those who can prepare a brief and translate it into action, much information is contained in the T.R.I. publications. Mr D. S. Jayawickrama gives an account of one of his experiences in our new feature, *Letters to the Editor*. It will be noted that his area was measured on the slope; had it been surveyed and given as a plan area, the extent would necessarily have been less. The yield could then hardly work out at less than 4,000 lb. of made tea per (plan) acre in 1959, from cuttings planted in 1956. It will be interesting to see how far such high yields can be achieved in normal estate management at full scale.

Dr F. R. TUBBS, C. B. E.

Many of the older planters in the Island will remember Dr Tubbs and the work that he did for the Industry in Ceylon. His name is associated with radical changes in pruning methods, especially in the low-country, with the initiation of vegetative propagation about 1936 and the TRI 202 series and other clones, and with the defeat of the blister-blight menace to the Industry in 1946-48. The formal details from "Who's Who" are given below. Mrs Tubbs is the daughter of the late Lewis B. Green of Ferham Estate, Lindula.

Dr Tubbs is now the Chairman and Convener of the Scientific Advisory Committee in the U.K. of the Tea Research Institute of Ceylon and in this connexion he will be in Ceylon for July, 1960, to familiarize himself with changes in the Industry since he left in 1948. During July, he will be able to visit a certain number of estates and perhaps attend some District Planters' Association meetings, but he does not wish to give formal addresses or make speeches.

Would those who would like Dr Tubbs to visit their estates or meetings please write to the Director, T.R.I., suggesting dates and times and mentioning personal or professional matters that are likely to be of interest.

TUBBS, FRANCIS RALPH, M.Sc., Ph.D., A.R.C.S., D.I.C., F.L.S., Director, East Malling Research Station since July, 1949; *b.* October, 1907; *s.* of William Edward and Elizabeth Clara Tubbs; *m.* 1939, Helen Beatrice Alice Green; two *s.* two *d. Educ:* Hackney Downs School; Imperial College of Science. Forbes Medallist, 1928; Research at Rothamsted, 1928-30; Plant Physiologist, Tea Research Institute of Ceylon, 1930-48. On active service, 1939-45, Lt.-Col. R.A.R.O., The Durham Light Infantry. Knight Order of Orange Nassau, 1946; Chevalier Order of Leopold II, *avec Palme*, 1946; Croix de Guerre, 1940, *avec Palme*, 1946. *Publications:* in scientific journals. *Recreations:* gardening and sailing. *Address:* East Malling Research Station, nr. Maidstone, Kent. *T.* West Malling 3033.

PLUCKING PRACTICES IN RELATION TO MAINTENANCE FOLIAGE

T. Visser

1. General

To pluck shoots each consisting of two leaves and a bud for tea making is recognized and normal: but this may be done as soon as the shoot has grown only that much above the fish-leaf (fish-leaf plucking) or it may be done later, when the shoot carries three leaves and a bud (single-leaf plucking). The single leaf that is left behind in the latter method contributes young and active material to the maintenance foliage. It is evident that in fish-leaf plucking the shoots are taken earlier, and the growth potential of the bush can then divert to other shoots, so that increased yield is possible. On the other hand, if the most active part of the maintenance foliage is never allowed to develop at all, there may, in the long run, be a weakening of the whole bush. The question is, therefore, where does the balance of advantage lie? As we shall see, a combination of the two procedures may be best, according to other circumstances.

In this connexion, the part played by the maintenance foliage may be considered somewhat more closely. After the bush has been in plucking for some time, the photosynthetic activity of the leaves in the lower layers of the bush will gradually diminish, as the shade increases from new leaves formed at a higher level. Light conditions will gradually become insufficient for photosynthesis; this is a contributory, if not the main, cause of the continuous fall (abscission) of leaves under the plucking table. The diminished efficiency of the foliage under the plucking table is borne out by the fact that removal of a major portion of it did not decrease the subsequent yield by any large amount (Visser, 1960).

There are also indications that when there is a loss of maintenance foliage carbohydrate production can be kept up because of increased activity of other leaves if the light conditions are improved. This is suggested in the case of side-pruning, where the removal of a part of the bush in dense fields is not followed by a proportionate decrease in yield (Visser, 1960). In one of our earlier trials, the yield of side-pruned bushes was actually higher than that of unpruned bushes (Visser and Tillekeratne, 1958). This phenomenon is attributable both to the predominance of the bush centre as regards yield and also to the increased photosynthesis of the remaining foliage as a result of improved light conditions following side-pruning.

Accordingly, there seems to be a possibility that the bush can be made to yield more by a controlled system of harder plucking, without undue harm to it. Since a number of fish-leaf-plucking trials have reached the stage when appraisal is possible, the question of whether and to what extent one can deviate from the normal plucking standard will be discussed on the basis of the results obtained so far.

2. Perennial Fish-leaf Plucking

History.—Eden (1942) started a plucking experiment in September, 1940, to examine the long-term effects of fish-leaf plucking on the tea bush. Since fish-leaf plucking is usual in Assam, it was thought that crop might be needlessly lost by not

adopting some form of this practice in Ceylon. It was realised, however, that the difference in pruning-cycle length was likely to be an important factor. In the annual pruning of Assam, very little wood is removed, whereas in Ceylon, with its longer pruning cycles, a considerable part of the frame is taken away.

Initially fish-leaf plucking seemed to have promising possibilities, judging by the results of the 1st cycle in 1944 (Eden, 1947, 1949), when the fish-leaf-plucked bushes yielded nearly 50% more than normally plucked bushes. On the other hand, the fish-leaf-plucked bushes had formed only about half the wood and less than half the foliage (in terms of prunings) of the normal control. Subsequent yields of bushes plucked to the fish-leaf over the 2nd cycle (unpublished), and the 3rd and 4th cycles (Portsmouth, 1950, 1953) were found to be lower than yields of bushes plucked to the single leaf; and a further decrease in foliage and wood formation was observed.

Following increased manuring with potash and removal of a number of heavy shade trees, fish-leaf-plucked plots yielded more in the 5th (Kehl and Piyasena, 1956) and 6th cycles (Visser, 1960); also foliage growth improved slightly and wood growth considerably.

Since the 3rd cycle, which began in December, 1946, certain treatments were reversed at each cycle (from fish-leaf to single-leaf plucking and *vice versa*) thus making it possible to assess the long-term damage done by fish-leaf plucking. It appeared that a change-over from fish-leaf to single-leaf plucking almost restored the growth potential of the bush in a single cycle (Portsmouth, 1950; Kehl and Piyasena, 1956; Visser, 1960).

The experiment, whose history has been summarized above, completed its 6th cycle (of 3 years) in November, 1958, and has now been discontinued. Previous reports have been short, so the data on the 4th, 5th and 6th cycles, will now be presented and discussed in greater detail.

Experimental Results.—The plucking treatments tested were:

(*a*) S S — continuous single-leaf plucking.
(*b*) F F — continuous fish-leaf plucking.
(*c*) S F — single-leaf plucking in the previous cycle, fish-leaf plucking in the next cycle.
(*d*) F S — fish-leaf plucking in the previous cycle, single-leaf plucking in the next cycle.

All treatments were tested at two levels of nitrogen application (4 replicates per treatment). The results obtained in the last 3 cycles are given in Table 1. Differences are regarded as significant at a level of P=0.05 or less and this level of difference is shown in a separate line labelled "Sign. diff.". The foliage and the wood referred to in Table 1 are those from the prunings.

Table 1.—*Flush, foliage, and wood production, as affected by the method of plucking, in lb. dry weight/acre/cycle of 3 years. Figures in brackets are the amounts expressed as percentages of S S, the control.*

4th cycle: 10/49—11/52

Treatments	Flush	Foliage	Wood
S S	2208 (100.0)	3284 (100.0)	5836 (100.0)
F S	1931 (87.5)	3072 (93.5)	5496 (94.2)
F F	1993 (90.3)	976 (29.7)	1584 (27.3)
S F	2326 (105.3)	1064 (32.3)	1692 (29.0)
Sign. diff.	104 (4.7)	217 (6.6)	1259 (21.6)

Potash then increased and *Albizzia* shade removed

5th cycle: 11/52—11/55

Treatments	Flush	Foliage	Wood
S S	3471 (100.0)	3232 (100.0)	8648 (100.0)
F S	3056 (88.0)	3192 (98.8)	7676 (88.8)
F F	4042 (116.5)	1020 (31.6)	2388 (27.6)
S F	4920 (141.7)	1148 (35.5)	2927 (33.8)
Sign. diff.	459 (13.2)	463 (14.3)	1126 (13.0)

6th cycle: 11/55—11/58

Treatments	Flush	Foliage	Wood
S S	3495 (100.0)	2716 (100.0)	7032 (100.0)
F S	3113 (89.1)	2644 (97.3)	6212 (88.3)
F F	3779 (108.1)	936 (34.5)	1708 (24.3)
S F	4513 (129.1)	1172 (43.2)	2204 (31.1)
Sign. diff.	357 (10.2)	374 (13.8)	488 (14.1)

Effect of Manuring.—Comparing the results of the 4th and 5th cycles presented in Table 1, there was a marked beneficial effect from increased potash manuring (from 20 to 40 lb./acre/year) and from removal of the heavy *Albizzia* trees at the start of the 5th cycle. Single-leaf-plucked plots (S S & F S) yielded on the average 58% more flush and 44% more wood (from prunings) and fish-leaf-plucked plots yielded 111% more flush and 62% more wood in the 5th cycle than in the 4th cycle. It is evident that the fish-leaf-plucked bushes benefited much more from the changed conditions of experiment than single-leaf-plucked bushes. Continuous plucking to the fish leaf, which in the 2nd, 3rd and 4th cycles decreased yield, produced in the 5th cycle significantly more flush than plucking to the single leaf.

It is quite probable that, apart from the favourable effect of increased potash application, the decrease in shade also played a part in enhancing the results of fish-leaf plucking. The maintenance leaves from a fish-leaf-plucked bush, with its thinner plucking table, are likely to profit more from the improved light conditions than bushes plucked to the single leaf.

The effect of increased potash manuring and decreased shade on maintenance foliage was negligible—average increases of only 2.5% and 6.3% for fish-leaf and single-leaf bushes respectively. This is not unexpected as the amount of foliage present on the bush is mainly determined by the type of plucking and by light conditions under the plucking table. Although the changed conditions (more potash and less shade) greatly encouraged flush production and thus increased the number of maintenance leaves left, light conditions for the lower layers of maintenance foliage would become too low sooner and lead to a higher rate of leaf fall.

Yield trends in the 6th cycle were very similar to those observed in the 5th cycle, but total growth was about 15% less for all treatments taken together, possibly due to less favourable climatic conditions in this cycle.

All four plucking treatments were tested at two levels of nitrogen, namely 40 and 80 lb. N/acre/year. The rates for phosphate (20 lb./acre) and potash (initially 20, later 40 lb./acre) were the same in both cases. The double dosage of nitrogen over the last three cycles increased the production of flush by 8–10%, of foliage by 9–12%, and of wood by 9–19%; significant interactions between nitrogen level and plucking treatment did not occur in any single instance. Under the conditions of the experiment, potash and shade rather than nitrogen seem to have determined the relative effect of the *type of plucking* on growth, particularly flush and wood production.

Effect of Plucking Method.—Apart from the favourable influence on yield of increased potash manuring and decreased shade, it is noteworthy that the main effects of the plucking treatments (see Table 1) have remained qualitatively the same over the past 9 years. This indicates that the bushes have reached a stage where treatment and response have become balanced. After the change-over from fish-leaf to single-leaf plucking, the bushes gave nearly as much maintenance foliage as with continuous normal plucking, but the bushes had not quite overcome the after-effects of previous fish-leaf plucking, for growth in terms of flush and wood was about 12% less than that of single-leaf-plucked bushes.

The change over from single-leaf to fish-leaf plucking produced in all instances more flush than plots plucked normally, presumably because the bush can draw upon reserves built up during the preceding cycle. Foliage and wood formation were somewhat better than those of bushes fish-leaf plucked throughout, but both treatments produced only about one-third of the prunings obtained from normally plucked bushes.

Table 2.—*Yields of flush from continuously fish-leaf and single-leaf-plucked bushes over 6 cycles* (1941–1958)

Plucking method	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle	6th cycle	Total over 18 years
Fish leaf ...	4430	1196	2006	1993	4042	3779	17446
Single leaf ...	3020	1492	2435	2208	3471	3495	16121
Difference ...	+1410	—296	—429	—215	+571	+284	+1325

As regards the long-term effect of the two main plucking treatments on yield, it can be seen from Table 2 that continuous fish-leaf plucking for 18 years yielded 8% more flush than continuous plucking to the single-leaf. This is rather surprising, taking into account the frame deterioration and the fact that the fish-leaf-plucked bushes yielded at pruning only about one-third of the maintenance foliage present on single-leaf-plucked bushes. Evidently, flush production has partly been maintained at the expense of shoot (wood) growth. The other factor which probably contributed to the undiminished flush yield is the enhanced photosynthetic activity of the maintenance foliage. Light conditions in fish-leaf-plucked bushes—due to the thin plucking table—are better and remain favourable for photosynthesis longer than in normally plucked bushes.

With respect to the long-term effect of perennial fish-leaf plucking in *alternate* cycles it appeared that it had given, over the 12 years of the test (since 1946), 19% more yield on the average than normal plucking throughout.

Recovery and Starch Reserves.—Table 3 gives an indication of recovery in terms of tipping weights recorded after pruning.

Table 3.—*Dry weights of tippings in lb./acre determined following pruning after completion of the 5th and 6th cycles. For meaning of symbols, see text relating to Table 1.*

Plucking treatments	After 5th cycle	After 6th cycle
S S	754 (100.0)	579 (100.0)
F S	665 (88.2)	439 (75.8)
F F	497 (65.9)	312 (53.9)
S F	637 (84.5)	422 (72.9)
Sign. diff.	90 (11.9)	74 (12.8)

The figures show that the bushes subjected to alternating treatments (S F and F S) recovered after pruning equally well, irrespective of whether they had been previously plucked to the fish-leaf or to the single-leaf, and notwithstanding the fact that the treatments had markedly different effects on foliage and wood growth in the preceding cycle.

Presumably, the constant treatment over *several* cycles produced a balanced framework and root system which was not significantly altered by a change in treatment in *one* cycle only. This is also borne out by the fact that the amount of tippings removed after the *first* cycle of the experiment was the same for fish-leaf and single-leaf-plucked plots, although fish-leaf plucking decreased total growth by one-third (Eden, 1947, 1949).

Recovery of those bushes that were continuously fish-leaf-plucked was significantly slower than that of bushes fish-leaf-plucked in alternate cycles and still slower than that of normally plucked bushes.

As regards the starch reserves of the differently plucked bushes, (Eden, 1944, 1945) determined starch indices during the first cycle; they indicated that roots of fish-leaf-plucked bushes contained almost the same amount of starch as those from single-leaf-plucked bushes. Actual starch contents were determined twice during the first year of the 7th cycle, at 7½ and 13 months after pruning, when the bushes had been plucked for 2½ months (10 plucks) and 8 months (29 plucks).

TABLE 4.—*Starch reserves (in % of dry weight) of roots of bushes continuously plucked to the fish-leaf and single-leaf respectively.*

Type of plucking	1st Sample August, 1959	2nd Sample January, 1960
Fish leaf ...	16.2	18.8
Single leaf ...	13.1	20.6
Sign. diff. at P=0.05 ...	2.8	4.7

Table 4 shows that roots of fish-leaf-plucked bushes contained initially a significantly higher percentage of starch than single-leaf-plucked bushes. This is presumably the result of slower recovery—slower mobilization of reserves—in the former case, as can be derived from the total weight of tippings and flush intake recorded up to the date of sampling; for fish-leaf-plucked bushes these were 32% less than for bushes plucked to the single-leaf. Further evidence of an inverse relation existing between percentage of starch reserves and recovery rate was furnished by the existence of a *negative* correlation between starch contents and yields (tippings + flush) of the individual plots amounting to —0.4532 (just not significant at P=0.05).

Sampling of the bushes when they were in full plucking showed that roots of single-leaf-plucked bushes tended to contain higher percentages of starch than fish-leaf-plucked bushes; this is presumably due to the presence of more maintenance foliage in the normally plucked bushes.

When comparing the data of the two samplings, it would seem that between 8 and 13 months elapse after pruning before the bushes have reached the stage in which starch reserves have been restored (see also Table 8 and page 45).

FLUSH AND BANJI FORMATION.—The proportions of flush and of banji shoots, and their weights, were determined throughout the 6th cycle. The data for 7 alternate plucks recorded in the same period in the 1st, 2nd and 3rd years after

pruning (in November, 1955) are given in Table 5. This table presents the averages for the two single-leaf-plucked and the two fish-leaf-plucked treatments, irrespective of the treatment in the previous cycle. It appeared that the type of plucking in the preceding cycle had no effect on subsequent flush and banji growth in the next cycle.

TABLE 5.—*Flush and banji shoot weights as affected by plucking methods and by time after pruning (fresh weights in mg.)*

Period	Flush weight S	Flush weight F	Banji weight S	Banji weight F	Avg. weight* S	Avg. weight* F	% Banji S	% Banji F
8/56—11/57 ...	684	578	503	447	659	543	23.5	29.4
8/57—11/57 ...	497	409	430	366	463	384	51.8	58.1
8/58—11/58 ...	481	408	467	406	474	407	52.0	62.0

S=perennial single-leaf plucking. F=perennial fish-leaf plucking.

*Based on total weight and total number of shoots of 7 samples.

Table 5 indicates that fish-leaf-plucking adversely affected the sizes of flush and banji shoots; they were on average 15% lighter than pluckable shoots from single-leaf-plucked bushes. Fish-leaf plucking also increased the proportions of banji shoots in the crop.

It is worthy of note that in the 1st year after pruning, shoot weights were much higher and banji percentages much lower than in the 2nd and 3rd year. Banji shoots are in all instances lighter than flush shoots, but the difference in weight tended to decrease with age after pruning (see also page 46).

3. Limited Fish-leaf Plucking

As it was clear from the results of the long-term plucking experiment that perennial fish-leaf plucking was detrimental to the bush, two experiments—one in the low country and one up-country—were initiated in 1955 and 1956 (Visser, 1957, 1959), with the object of investigating the practical possibilities of limited fish-leaf plucking.

The principal difference between these trials and the older experiment was that the bushes were normally plucked for some time after pruning in order to allow them to develop a fair canopy of maintenance foliage before fish-leaf plucking began.

3.1 The St. Coombs Experiment.

EXPERIMENTAL.—This trial was laid out in August, 1955, and consisted of the following treatments (each replicated 5 times), manured at a ratio of 8 and 12 lb. N/100 lb. tea respectively (N:P:K=8:4:5):

(*a*) S S S S — continuous plucking to the single-leaf.

(*b*) S S F F — nearly 2 years normal plucking (10/55—8/57) followed by 2 years fish-leaf plucking until pruning (9/59).

(*c*) S F F F/R — 10 months single-leaf plucking (10/55—8/56) followed by $2\frac{1}{2}$ years fish-leaf plucking (8/56—3/59) and then rested for 6 months until pruning.

(*d*) S F F F/S — 10 months single-leaf plucking followed by $2\frac{1}{2}$ years (8/56—2/59) fish-leaf plucking and then, after 1 month of resting, single-leaf plucked again (6 months) until pruning.

Twice during the experiment the canopy of the fish-leaf-plucked bushes was considered unsatisfactory (due to drought and mites); the bushes were then rested for 2 rounds and 1 round was plucked normally before fish-leaf plucking was resumed.

The experiment completed its first cycle of 4 years in September, 1959; the yields obtained in the individual years have been reported elsewhere (Visser, 1960). The total yield, the amount of residual maintenance foliage and wood obtained from the prunings, and the tipping weights recorded after pruning, are shown in Table 6.

TABLE 6.—*Cycle yield, foliage and wood production, and tippings, as affected by restricted fish-leaf plucking, in lb. dry weight per acre: the symbols are explained in the text*

Treatment	Flush	Foliage	Wood	Tippings
(*a*) S S S S ...	4409 (100.0)	4025 (100.0)	11775 (100.0)	568 (100.0)
(*b*) S S F F ...	5671 (128.6)	3325 (82.4)	9275 (78.8)	614 (108.1)
(*c*) SFFF/R ...	5756 (130.6)	5050 (125.5)	8125 (68.9)	553 (97.4)
(*d*) SFFF/S ...	5960 (135.2)	3850 (95.7)	8125 (68.9)	605 (106.5)
Sign. diff. ...	227 (5.1)	750 (18.6)	2000 (17.0)	57 (10.0)

It can be seen from Table 6 that fish-leaf plucking preceded by 1 or 2 years single-leaf plucking gave between 1,260 lb. and 1,550 lb. of tea per acre per cycle more than single-leaf plucking throughout. The amount of maintenance foliage at the time of pruning was for plots (*b*), fish-leaf plucked for 2 years, significantly lower, and for plots (*c*), rested at the end of cycle, significantly higher than that of the control (*a*); the foliage of bushes on plots (*d*), single-leaf plucked at the end of the cycle, was approximately the same as in the control.

As regards wood growth, fish-leaf plucking during part of the cycle had a significant depressing effect which was greater, the longer the period of fish-leaf plucking (Table 6).

However, when comparing the depressing effects of limited and perennial plucking (after one cycle), it is clear that limited fish-leaf plucking has been much less harmful to the bush than perennial (Table 7).

TABLE 7.—*Relative effect of perennial and limited fish-leaf plucking on foliage and wood production (in terms of prunings) after the 1st cycle of 4 years*

Fish-leaf plucking	Foliage[3]	Wood[3]
Limited[1] ...	80	79
Perennial[2] ...	37	54

1. Two years normal and 2 years fish-leaf plucking.
2. Figures obtained from Eden (1949).
3. Foliage and wood expressed in percentages of that of single-leaf-plucked bushes.

Bushes where fish-leaf plucking was preceded by normal plucking carried more than twice as much maintenance foliage by the end of the pruning cycle as did bushes fish-leaf-plucked throughout. As it can be assumed that, during the fish-leaf plucking stage, not much foliage is added, it would appear that a considerable

part, if not the greater part, of the foliage present at the time of pruning must have been formed two years previously when the bushes were plucked to the single leaf. With respect to bushes plucked continuously to the fish-leaf (1st cycle), Eden (1947) remarked that the foliage remained almost static from the time of tipping. This means that the maintenance leaves on fish-leaf-plucked bushes are subject to a very much lower abscission rate than those on normally plucked bushes, as a result of the better light conditions in the plucking table.

Recovery and Starch Reserves.—Judging by the recovery of the bushes, which in terms of tipping weights (Table 6) was approximately the same for all treatments, fish-leaf plucking during part of the cycle does not seem to have impaired the health of the bushes.

Further information about the condition of the bushes was sought by determining the starch content of roots of certain treatments at the time of pruning, at the end of 4 years plucking, and about 4 months later when the bushes had reached the tipping stage (Table 8).

Table 8.—*Starch contents (in % of dry weight) of roots of bushes continuously single-leaf plucked or fish-leaf plucked during part of the cycle*

Type of plucking	1st Sample Sept. 1959	2nd Sample Jan. 1960
(*a*) S S S S ...	22.7	12.4
(*c*) S F F F/R ...	21.6	9.4
(*b*) S S F F ...	19.9	—
Sign. diff. a/b	1.7	
at P=0.05 a/c	2.9	2.7

It follows from Table 8 that roots of bushes plucked to the fish-leaf during the 2nd half of the cycle (S S F F) contained at the time of pruning significantly less starch than roots of continuously single-leaf-plucked bushes. Resting for half a year before pruning enhanced the starch reserves; the starch content of the fish-leaf-plucked and rested bushes (S F F F/R) did not significantly differ from that of the control.

The second sampling done at tipping time shows a marked depletion of reserves following recovery after pruning. The starch reserves of the fish-leaf-plucked and rested bushes were significantly lower than those of the control. This does not necessarily mean that the health of the former bushes was impaired; it may in fact point to a quicker mobilisation of reserves (see comments on Table 4, page 42).

Manurial Response.—With respect to differences in response to manuring at the 8 and 12 lb. N ratio, it appears that the higher ratio increased flush production by 15 to 21%; there was no interaction between manuring and plucking treatment. The increased rate of manuring (per 100 lb. tea) increased the weight of prunings of single-leaf-plucked bushes by 6%, but was accompanied by an average decrease of 12% with bushes fish-leaf-plucked for part of the cycle.

A similar phenomenon was observed in the trial at Endane (see page 47). It seems quite likely that the fish-leaf-plucked bushes treated at the higher ratio were slightly over manured, because they received about 20% more manure *per acre* while producing less growth (flush + foliage + wood) than single-leaf-plucked

bushes. Growth may have been adversely affected, either directly by such an overdose (or possibly that of one of the components of the mixture) or indirectly if the overdose limited the uptake of other elements.

As an increase in nitrogen or potash application *only* had a favourable effect in the long-standing plucking experiment it may be that too much phosphate was given per acre.

Flush and Banji Formation.—At every alternate plucking round, random samples were taken of each plot in order to determine both the proportions of flush and banji shoots in the crop and their individual weights. Table 9 gives the averages of 7 alternate plucking rounds recorded in the 2nd, 3rd and 4th years after pruning (in August, 1956) for two treatments.

Table 9.—*Flush and banji shoot weights as affected by time after pruning and by plucking method (fresh weights in mg.)*

Period	Flush weight S	Flush weight F	Banji weight S	Banji weight F	Average weight* S	Average weight* F	% Banji S	% Banji F
10/56 — 1/57 ...	586	475	495	444	542	468	48.0	41.5
10/57 — 1/58 ...	527	443	448	415	488	430	50.5	54.4
10/58 — 1/59 ...	430	393	424	366	430	377	52.7	58.5

S = continuous single-leaf plucking. F = fish-leaf preceded by normal plucking for one year.
*Based on total weight and total number of shoots of 7 samples.

Table 9 shows that the weights of flush and of banji shoots decrease and the percentage banji increases with time after pruning for both fish-leaf-plucked and single-leaf-plucked bushes. Pluckable shoots from the former were on average 13% lighter than from the latter treatment (average weight 425 and 487 mg.). These observations conform with those of Tubbs (1937) made in a study on shoot growth in relation to time after pruning. The fish-leaf-plucked bushes formed initially less banji shoots, probably due to a stimulating effect following the change over to harder plucking (August, 1956), but later produced more banjis than single-leaf-plucked bushes.

3.2 The Endane Experiment.

Experimental.—The purpose of this trial was mainly to test pruning cycles of different lengths, comparing at the same time the effect of two manuring ratios and the effect of continuous single-leaf plucking in comparison with limited fish-leaf plucking (Visser, 1957). In the latter case, fish-leaf plucking (preceded by about 6 months single-leaf plucking) commenced 9 months after pruning. The two manuring rates were, as in the St. Coombs experiment, 8 and 12 lb. N per 100 lb. tea, with a mixture of which the proportions were N:P:K = 8:4:5.

The experiment completed a 3-year cycle in September, 1959; the main results —as regards the effect of pruning-cycle length—have been reported elsewhere (Visser, 1960).

Effect of Plucking Methods.—Table 10 summarizes the data with respect to the two plucking treatments (of plots pruned every $1\frac{1}{2}$ and 3 years).

TABLE 10.—*The effect of 3 years continuous single-leaf and limited fish-leaf plucking on growth in terms of flush, prunings, tippings, and dieback, in lb. per acre*

Type of plucking	Flush (DW)	Prunings (FW)	Tippings (DW)	Dieback (FW)
Single leaf ...	4235 (100.0)	20014 (100.0)	169 (100.0)	665 (100.0)
Fish leaf ...	4858 (114.7)	18102 (90.4)	174 (103.0)	695 (104.5)
Sign. diff. at P=0.05	159 (3.8)	590 (2.9)	Difference not sign.	Difference not sign.

N.B. Figures within parentheses are yields in percentages of control.
DW=dry weight. FW=fresh weight.

It can be seen from Table 10 that limited fish-leaf plucking significantly increased flush yield by about 15% and decreased growth in terms of prunings by about 10%. Bushes fish-leaf plucked for part of the cycle showed recovery which was no different from that of single-leaf-plucked bushes, as can be seen from the fact that tipping and die-back weights recorded after pruning were the same for both treatments.

The increase in yield by limited fish-leaf plucking was approximately half of that obtained at St. Coombs. It is possible that this is due to the lower starch reserves of bushes growing at a low altitude and loss of maintenance foliage as a result of Shot-hole Borer and ~~*Cercosporella*~~. Red Rust (*Cephaleuros parasiticus*).

MANURIAL RESPONSE.—Manuring at a higher rate (12 lb. N/100 lb. tea) had little effect on flush production, resulting in only 4% more crop compared with manuring at the lower rate (8 lb. N). Neither tippings nor die-back weights were significantly affected by increased manuring. The effect on the weight of the prunings depended on the plucking treatments; pruning weight of the single-leaf-plucked bushes increased by 5%, that of fish-leaf-plucked bushes decreased by 5%. The same phenomenon was noticed in the experiment at St. Coombs, possibly indicating over-manuring in the case of fish-leaf-plucked bushes manured at the 12 lb. ratio (see page 45).

4. Discussion and Conclusions

There are several reasons why fish-leaf plucking markedly increases yield

The first factor is that less time is required to form a flush shoot with two leaves and a bud (or an equivalent banji shoot) than to form a shoot with three leaves. The average time it takes to unfold a new leaf on a shoot was found to be 6.3 days by Tubbs (1939), 7.7 days by Visser (1958) and 9.0 days by Portsmouth (1957) or say about a week. It is known (Portsmouth, 1957; Visser, 1958) that development of an axillary bud into a pluckable shoot (of which the single leaf is left when plucked) takes an average of about 77 days up-country (St. Coombs). Accordingly, one may assume that about 10% of the yield increase by fish-leaf plucking is accounted for by the shorter period that the shoot is left on the bush. This is possibly an underestimate, as the growth rate of shoots on fish-leaf-plucked bushes may be higher.

The second and main factor is that fish-leaf plucking very markedly increases the number of plucking points. At St. Coombs where the average yield over the 2nd and 3rd year was about 60% higher (Visser, 1960) and the shoots 13%

lighter, fish-leaf-plucked bushes must have had on the average about 80% more plucking points than single-leaf-plucked bushes. This increase is not due to a greater number of primary shoots, but due to "multiple" shoot growth. That is to say, the axil of a fish-leaf often produces two shoots, while normally only one shoot is formed in the axil of a single leaf. Furthermore, it also happens that dormant buds on the sides of fish leaves previously formed (often abscissed at that time) develop into pluckable shoots (in that case, the axil of the apical fish-leaf usually carries only one shoot). The latter rarely happens on single-leaf-plucked shoots, probably partly because single leaves previously formed are already under the plucking table, where light conditions are no longer favourable for photosynthesis, thus impeding bud activity.

On the other hand, maintenance leaves (and fish leaves) of fish-leaf-plucked bushes enjoy good light conditions for a long time because the height of the plucking table increases only slowly. The unimpaired yield capacity of fish-leaf-plucked bushes is undoubtedly partly the result of the enhanced efficiency of the foliage and fish leaves in synthesizing carbohydrates because of the better light conditions. This is also borne out by the fact that starch reserves of roots from fish-leaf-plucked bushes are not much lower, though their foliage is less, than those of single-leaf-plucked bushes. Since its abscission rate is much lower, the foliage of fish-leaf-plucked bushes also remains active longer than that of bushes plucked to the single-leaf.

Last but not least, mention must be made of the fact that fish-leaf plucking stimulates leaf growth at the expense of wood growth. In a sense, hard plucking resembles hard pruning, in so far as it leaves less wood but stimulates the activity of buds which would otherwise remain dormant.

The long-term plucking experiment showed that *continuous fish-leaf-plucking* can be done over many years without losing crop (increase over 18 years was 8%). However, it was abundantly clear that it greatly weakened the bushes and almost certainly must also have been detrimental to soil conditions. Continuous fish-leaf plucking causes a considerable loss in organic material in terms of diminished wood (and root) growth and leaf droppings. The latter loss is estimated to be of the order of 80% as compared with normally plucked bushes (Visser, 1960*a*). Further, the less dense soil cover provided by fish-leaf-plucked bushes is an unfavourable factor. Accordingly, perennial fish-leaf plucking must stand condemned as a normal estate practice.

Fish-leaf plucking in alternate cycles proved to be less harmful, for the bushes all but recovered from the after-effects of fish-leaf plucking in the first cycle in which they were plucked normally. This system of plucking led to a 19% increase in yield over 12 years. The disadvantages are again that the soil cover and the supply of organic material become inadequate in the fish-leaf-plucking cycle.

Limited fish-leaf plucking—that is fish-leaf plucking preceded by plucking to the single leaf during the first part of the cycle—appeared to have practical possibilities at *up-country* elevations, as its effect on growth was not unduly detrimental. The best method would seem to be *fish-leaf plucking, preceded by single-leaf plucking for* 10 *months after tipping, and succeeded by* 6 *months resting at the end of the* (4 *years*) *cycle:* This system increased the yield by 30%. The advantage of resting prior to pruning is that it enhances the carbohydrate reserves which have been reduced by the preceding fish-leaf plucking.

The average starch contents of roots—from bushes in adjacent fields (Tables 4 & 8)—give a fair indication of starch reserves in relation to pruning (Table 11).

TABLE 11.—*Starch percentage of roots at various times after pruning*

Months after pruning	4** (tipping)	7½*	13**	48* (pruning)
Starch % ...	10.9	14.6	19.7	21.4

*August/September 1959. **January 1960.

They show (Table 11) that the starch reserves at tipping time had been reduced to about half the amount initially present and that at least one year elapses after pruning before the starch reserves of regularly plucked bushes have been built up again. These observations are in fair agreement with those of Tubbs (1935), who deduced from the close relation between variations in flush weight and in the weight of maintenance foliage following recovery that carbohydrate supplies are low for more than a year after tipping when the bush is regularly plucked. Presumably only after this period does the bush attain a sufficiently large leaf area to enable it to balance its reserves. This supports the desirability of allowing the bush to form sufficient maintenance foliage by single-leaf plucking first before fish-leaf plucking commences. Lack of sufficient foliage would also unfavourably affect the growth of the branches (Tubbs, 1932).

Limited fish-leaf plucking under low-country conditions led to a smaller increase in yield than up-country (15% increase versus 30%). This can probably be partly attributed to the shorter cycle and partly to the lower starch reserves, while depletion of the maintenance foliage by Shot-hole Borer and *Cercosporella* may have played a part as well. However, limited fish-leaf plucking for 3 years did not appear to have harmed the bushes, judging by the facts that the weight of prunings decreased only a little, recovery was unimpaired, and dieback not significantly more than that of single-leaf-plucked bushes. Also, the yields of fish-leaf-plucked bushes showed no tendency to decrease over the 3 years of the experiment; bushes pruned every 1½ years produced in the 1st, 2nd and 3rd years of the trial respectively 5.5, 12.5 and 18.5% more crop than single-leaf-plucked bushes.

With respect to *manuring* of *high-yielding* fish-leaf-plucked bushes, indications were obtained that the application of a high ratio may be over manuring. The 12 lb. N ratio per 100 lb. tea, though it increased flush, was found to depress wood growth to some extent.

As regards the components of the mixture, phosphate rather than nitrogen or potash may be the depressing factor in our case, where both a high ratio per 100 lb. tea and a high rate per acre (because the yield was high) were applied. On the other hand, an indirect effect of the over-manuring resulting in decreasing the availability of other elements cannot be ruled out.

Estimations of *organic material* supplied by regularly plucked bushes (Visser, 1960*a*) showed that single-leaf plucking provided both in the low-country and at up-country altitudes about 1 ton of dry organic matter in the form of leaf droppings and 1 ton in terms of prunings per acre per year. Bushes plucked to the fish-leaf for part of the cycle produced about one quarter less than single-leaf-plucked bushes.

Regarding the effect of fish-leaf plucking on *quality*, it was observed that continuous fish-leaf plucking in the first cycle of the long-term experiment led to a very marked diminution (by 30%) of flush size (Eden, 1947). A preliminary trial (Lamb, 1945) indicated that the colour of teas made from this leaf increased, but strength and quality had declined. Shoot-weight determinations made in the 6th cycle of the older trial and in the first cycle of the newer trial showed that pluckable shoots from fish-leaf-plucked bushes were on the average 13 to 15% lighter than those of single-leaf-plucked bushes. The diminution in flush size, though significant, is much less marked than observed by Eden during the 1st cycle of the older trial, probably because of improved manuring practices since then and the

fact that in our case the bushes were fish-leaf plucked for part of the cycle only. As no tests have been carried out recently, it is not known whether the plucking system affected the made tea.

5. Practical Aspects

Perennial fish-leaf-plucking, being harmful to the bush, is *not* recommended, except when fields are to be uprooted. When uprooting is planned, continuous fish-leaf plucking is an advantageous practice, as the increased crop (possibly of the order of 50%) will contribute to the costs of replanting. The earlier the fields are earmarked for uprooting, the greater are the benefits that can be reaped.

Limited fish-leaf plucking gave, in both high and low country, results which warrant its trial on estates. Up country, an increase of the order of 30%—in our trial, equivalent to 330 lb. tea/acre/year—seems possible if fish-leaf plucking is preceded by 10 months of normal plucking and succeeded by 6 months of resting before pruning in a 4 year cycle. With a cycle of 3 years, more common in the mid-country, the same system could be applied; possibly the period of resting could be shortened to 4–5 months.

Under low-country conditions, fish-leaf plucking for the last 9 months of a 1½-year cycle and preceded by 6 to 7 months of single-leaf plucking after tipping can be expected to yield 10 to 15% more—in our trial equivalent to 200 lb. tea/acre/year more.

It is *essential* that fish-leaf plucking is applied only on mature and vigorous bushes; poor fields should not be subjected to it.

In the low country and the mid-country, where the bushes often suffer from Shot-hole Borer and *Cercosporella*, depletion of maintenance foliage can more easily occur than up-country. As also starch reserves are lower, it is most important to avoid or correct undue depletion of the maintenance foliage. If this were to occur due to disease, pests, or drought, a few rounds of resting followed by 1 or 2 rounds of normal plucking should be resorted to before fish-leaf plucking is resumed.

Where our trials have shown that fish-leaf plucking for about half the cycle is not detrimental to the bush, then naturally fish-leaf plucking for a few months in the year is not likely to harm the bush either. In fact it is common practice on many estates to fish-leaf pluck during the rush season and pluck to the single leaf for the rest of the year.

It seems to me, however, that the reverse of this procedure would be advantageous under certain circumstances. Crop intake during the rush season is often already so high that it taxes the capacity of the factory; fish-leaf plucking then aggravates this problem. Instead, normal plucking during the rush season followed by fish-leaf plucking in the flavoury (dry) season would have the advantage that it would tend to reduce the crop when the yield is high and prices are low, and increase the crop when it is normally low but prices are better.

Fish-leaf plucking during the dry season may assist in counteracting the effects of drought by decreasing evaporation; it is in any case more profitable than stripping which is sometimes advocated during severe droughts.

Attention must also be drawn to *breaking-back* and *plucking below the table*. Both practices—which amount to harder plucking—have been found to increase yield substantially (Eden, 1945; Visser, 1960; Visser and Tillekeratne, 1958).

Plucking below the table should be applied with discrimination (healthy bushes only!) and tried out according to the following principles:—

(*a*) plucking below the table only around the *periphery* during the first 14–16 months after tipping only, to restrict the size of the bush in fields which are densely planted or where bushes expand to such an extent that movement through the rows becomes difficult later in the cycle;

(*b*) plucking below the table in the *centre* should *not* be applied during the first 10 to 14 months after tipping, because it is important that the bush forms a good canopy of foliage first;

(*c*) plucking below the table should *not* be applied *at all* in fields which are to be fish-leaf plucked later.

Although plucking below the table is not normally done in Ceylon, it is noteworthy that pluckers on some estates in Indonesia were specifically trained to do so. On theoretical grounds the practice seems sensible, because shoots formed below the plucking table are not likely to contribute for long to the synthesis of carbohydrates, since light conditions will quickly become unfavourable there.

With respect to *manuring* of bushes fish-leaf plucked for part of the cycle, the application of the same ratio and mixture normally applied was found to give satisfactory results. Some indications were obtained that a rather high ratio—in our case 12 lb. N per 100 lb. tea—slightly depressed wood growth, possibly because too much phosphate is then applied. It should not be forgotten that when manuring is calculated as a ratio to crop, since fish-leaf plucking increases the yield, much more manure is applied *per acre*, although *total growth* (flush, foliage, wood) will tend to be less than that of normally plucked bushes.

Since conditions differ from place to place, planters, particularly in the mid-country, would be well advised first to try out the methods of plucking discussed here on one field, in order to assess the effects under their own conditions before applying them to large acreages. Practical trial is certainly worth while, for the rewards may be substantial.

Undoubtedly, problems of management will play a significant part and will have to be considered; can labour be trained and disciplined to do fish-leaf plucking today, and single-leaf plucking tomorrow? If they can anywhere, surely they can in Ceylon.

Summary

1. By fish-leaf plucking is meant plucking the tea shoot as soon as it has two leaves and a bud; when the shoot is allowed to grow more, so that plucking two leaves and a bud leaves a young leaf behind, that is called normal or single-leaf plucking.

2. Fish-leaf plucking prevents the continuous addition to the maintenance foliage of young leaves, an addition that is characteristic of single-leaf plucking; in the long run, continuous fish-leaf plucking harms the bush, but it takes a long time to do so.

3. Fish-leaf plucking always gives a bigger crop.

4. If fish-leaf plucking is practised for one pruning cycle or less, normal treatment readily brings the bush into condition again. Such ill-effects as there are can be guarded against by normal plucking for some time after tipping, and by resting before pruning.

5. Fish-leaf plucking can be very profitable for two to four years up-rooting tea; it can be used to help to smooth out yield over the year by applying it in the dry season, plucking normally in the rush season; and, by careful management, it can be intermittently applied to increase crop.

Acknowledgments

My thanks are particularly due to Mr M. Piyasena who has for so many years conscientiously managed the plucking experiments. I have also to acknowledge the assistance of Mr S. Nagarajah as regards the starch determinations and that of Mr L. M. De Waas Tillekeratne with respect to the statistical analysis of the experiments.

References

Eden, T. (1942). Report of the Agricultural Chemist for 1941. *Bull. Tea Res. Inst. Ceylon*, no. 23: 56–57.

Eden, T. (1944). Report of the Agricultural Chemist for 1943. *Bull. Tea Res. Inst. Ceylon*, no. 25: 44–45.

Eden, T. (1945). Report of the Agricultural Chemist for 1944. *Bull. Tea Res. Inst. Ceylon*, no. 26: 42–43.

Eden, T. (1947). The effects of hard plucking (with special reference to Blister Blight). *Tea Quart.* **19:** 105–109.

Eden, T. (1949). Work of the Agricultural Chemistry Department of the Institute, 1927-1948. *Tea Res. Inst. Ceylon, Monograph* no. 1: 25–27.

Kehl, F. H. & Piyasena, M. (1956). Report of the Plant Physiology Department for 1955. *Bull. Tea Res. Ceylon*, no. 37: 48-49.

Lamb, J. (1945). Report of the Biochemist for 1944. *Bull. Tea Res. Inst. Ceylon*, no. 26: 62.

Portsmouth, G. B. (1950). Report of the Plant Physiologist for 1949. *Bull. Tea Res. Inst. Ceylon*, no. 31: 36–37.

Portsmouth, G. B. (1953). Report of the Plant Physiologist for 1952. *Bull. Tea Res. Inst. Ceylon*, no. 34: 38–39.

Portsmouth, G. B. & Rajiah, E. S. (1957). Factors affecting shoot production in tea (*Camellia sinensis*) when grown as a plantation crop. III. The time factor and new shoot production. *Tea Quart.* **28:** 21–29.

Tubbs, F. R. (1932). Defoliation. II. The effect of defoliation on the yield of flush and on the thickness of the pruning wood. *Tea Quart.* **5:** 148–153.

Tubbs, F. R. (1935). Report of the Plant Physiologist for 1934. *Bull. Tea Res. Inst. Ceylon*, no. 16: 35–36.

Tubbs, F. R. (1937). The length of the pruning cycle. *Tea Quart.* **10:** 21–36.

Tubbs, F. R. (1939). Report of the Plant Physiologist for 1938. *Bull. Tea Res. Inst. Ceylon*, no. 19: 50–55.

Visser, T. (1957). Report of the Plant Physiologist for 1956. *Bull. Tea Res. Inst. Ceylon*, no. 38: 43.

Visser, T. (1958). Growth rates and weights of flush and banji shoots of clones (*unpublished data*).

Visser, T., & Tillekeratne, L. M. De Waas (1958). Factors affecting planting distances of tea. *Tea Quart.* **29:** 36–44.

Visser, T. (1959). Report of the Plant Physiologist for 1958. *Annu. Rep. Tea Res. Inst. Ceylon*, 58–59.

Visser, T. (1960). Report of the Plant Physiologist for 1959. *Annu. Rep. Tea Res. Inst. Ceylon for* 1959 (*in preparation for press*).

Visser, T. (1960*a*). Estimation of organic matter supplied by regularly plucked tea bushes. (*in preparation*).

VEGETATIVELY PROPAGATED TEA PLANTS: GROWING AND TRANSPLANTING ECONOMICALLY

*Arthur Watt
Endane Estate

The replanting of tea with vegetatively propagated material or the planting of new clearings from jungle or patana grass is still in its infancy, and very few estates have got beyond the experimental stage of planting from one to five acres per annum.

Where experimental planting has been done, the internode cuttings have usually been rooted in various types of soil and afterwards transplanted into supply baskets. This method undoubtedly gives excellent results and is all very well where only a few acres are involved, but what is to be the position if planting in subsequent years has to be increased and becomes annual? From where are the large quantities of good soil to be procured to fill the baskets? What about the cost, and what about the large areas of land which will have to be laid to waste by removal of top soil to fill supply baskets? The method, apart from being expensive, is very wasteful and cannot continue indefinitely. Alternative methods will have to be adopted.

The following are a few details of a simple and economical method of producing planting material. It has been tried for a number of years, during which time over 70 acres of clearings have been planted, of which 20 are in bearing.

During the period a few very bitter lessons have been learnt. The first was never to try to be economical with planting material in relation to the size of the clearing. The nursery should contain about twice the number of plants estimated to be required. Any surplus left over after the first planting will be most useful for filling in vacancies a few weeks later. A second or even a third round of resupplying can go a long way in giving an even and regular stand. If surplus plants are still available, poor and exposed parts of the clearing will greatly benefit by doubling the number of plants in the rows. Plant selection in the nursery should not be overlooked.

The nursery site should be central, to cover the planting areas programmed over a number of years; this avoids making new nurseries at frequent intervals, which works out to be more expensive than reconditioning. The site should have a gravity-fed water supply or, failing this, enough water that can be pumped from a reasonable distance.

Nursery beds are best if built on the contour, a convenient width being three feet, with about one foot between the beds. Good drainage is essential; to ensure this, beds should be raised twelve to fifteen inches in height. To check erosion or earth-fall from these high beds, round timber can be pegged along the sides up to a height of six to eight inches. If timber is not available, a more expensive alternative is a stone terrace.

---

* The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

Having completed the building of the beds, soil fumigation is advisable. The next step is the construction of wooden frames to support a fern canopy for shade. This frame-work need not be expensive and can be made from round timber such as *Gliricidia* poles or branches from jungle trees. Fern when spread on top should be sufficiently thick to prevent the direct rays of the sun penetrating to the bed, but at the same time to allow a little filtered light to get through.

The figure on page 55 indicates the types of bed and of shade suggested.

Having placed the shade, cuttings can be planted, provided at least two weeks have elapsed since the soil was fumigated. Best results have been obtained by planting the cuttings at 4 inch spacing on the diagonal. On this basis, it has been found that a one-acre nursery will take about 400,000 cuttings, thus allowing nearly 12 square inches per cutting, plus space between the beds.

From the time of planting, fern shade requires careful watching and should be thinned out as the growth of the plants proceeds. It should be completely removed at least 2 months before the plants are due for transplanting into the clearing.

For watering, one of the many types of sprinkler system is strongly recommended; the saving in labour costs will pay for the installation over a year or two. Provided a gravity-fed water supply is available with sufficient head for pressure purposes, a sprinkler installation of sufficient size to water a nursery containing 750,000 cuttings can be purchased for Rs. 2,000/-.

While in the nursery, the plants require frequent manuring at intervals of not more than two months; excellent results have been obtained by the exclusive use of refuse tea applied after the cuttings have rooted.

At an elevation of approximately 1,000 ft. above sea level, the plants have been found ready for transplanting direct into the clearing at eight months; at this age they are about pencil thickness and from 15 to 18 inches in height.

The following are details of costs of producing plants ready for transplanting into clearings from a nursery in its second year of cultivation. To start a new nursery on new land, the cost per plant will be increased by three cents. The costs are calculated on 600,000 plants, grown from approximately 750,000 internode cuttings planted, with cost of labour at Rs. 2.43 per head per day:—

Item No.	Description	Total cost	Cost per plant
		Rs.	Cents
1	Digging old beds and thoroughly loosening soil ...	793	.13
2	Levelling and remaking beds	3185	.53
3	Transporting and laying new jungle soil approximately ½ inch thick on top of beds	3062	.51
4	Collecting sticks, making shade frames, and fixing fern ...	4400	.73
5	Cost of fern and transport	932	.16
6	Taking internode cuttings and planting into beds ...	6149	1.03
7	Watering	782	.13
8	Weeding, etc.	890	.15
9	Transport of refuse tea and application	787	.13
10	Cost of two watchmen	1190	.20
11	Cost of Nematox, fumigating soil and application of fungicides for Blister Blight, etc.	856	.13
12	Sundries	135	.02
13	Part cost of sprinkler system	500	.08
	Total ...	23661	3.94

Removing plants from nursery beds and transplanting into clearing

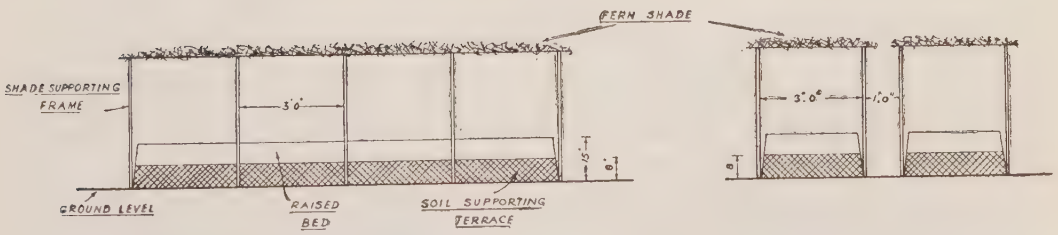
Considerable care is necessary when removing plants from nursery beds to avoid damaging the roots. A good method is to dampen the bed thoroughly with water before loosening up the soil with a digging fork; the plants can then be removed easily, with soil still attached to the roots. They should be carefully placed into transport boxes measuring about 2 ft. × 1½ ft. These boxes will hold up to 45 plants and can be either transported by lorry or carried by labourers.

Only reliable persons should be used for transplanting; the job requires and deserves the closest supervision possible. Each labourer should be given a small hand fork to loosen up the soil thoroughly in the hole, remove stones or other solid matter, and shape a suitable bed to take the plant, with its roots spread out in their natural position. If the latter procedure is not carefully done, casualties will result. The plants must be planted at their nursery level; this is most important.

Immediately after planting, they should be shaded with fern; if this is not available, baskets will suffice, but best results have been obtained with fern. It not only provides shade, but acts as a good anchorage for the plants until the roots have taken hold. Should the clearing be in an exposed area and subject to strong wind, it will be found beneficial to cut the leaves across to about 50% in size and tie the plant to a peg.

The following are approximate costs:—

	Per 100 plants.
Cost of removing plants from nursery, transporting to field and planting	Rs. 1.42
Cost of fern (collecting and transporting)	,, 1.28
Labour fixing fern, etc.	,, 1.30
Total ...	Rs. 4.00



SIDE ELEVATION

END ELEVATION

A FORECASTING SYSTEM FOR BLISTER-BLIGHT CONTROL, BASED ON SUNSHINE RECORDS

D. Mulder and R. L. de Silva

Blister-blight control has developed into an accepted routine practice on all estates that suffer from this disease but its costs weigh fairly heavily on the economy of the estate.

If the average cost of one spraying round is taken as Rs. 2/- per acre and a 1,000-acre estate is sprayed twenty times a year, then the estate spends Rs. 40,000/- annually, on blister-blight control alone. A reduction of the number of spraying rounds by only four would mean an annual saving of Rs. 8,000/-. Some actual figures have been provided by seven estates in the Dimbula district.

TABLE 1.—*Costs of blister-blight control in* 1959 *on seven estates in the Dimbula District*

Estate No.	Acreage	Number of rounds	Costs per acre per round Rs.	Costs per lb. cents	Total costs Rs.	Costs per round Rs.
1	260	23	2.33	5.1	14,312	620
2	325	16	2.16	4.2	11,000	687
3	791	22	2.08	5.4	37,000	1,680
4	835	18	1.63	3.3	25,000	1,380
5	650	22	1.72	4.2	24,936	1,133
6	772	22	1.82	4.6	32,280	1,460
7	641	18	2.45	4.5	27,062	1,440

It is clear that a forecasting system for deciding whether it is really necessary to spray or not, might be of considerable economic importance. Previous reports on a forecasting system according to sunshine have been given by Mulder (1959) and Visser, Shanmuganathan and Mulder (1959).

Work by Visser, Shanmuganathan and Sabanayagam as yet unpublished, indicates that sunshine effectively controls Blister Blight by killing the spores; an average of 4 hours sunshine per day over a period of four or five days makes spraying on the day following that period superfluous. Thus a total of 20 hours sunshine for a 5-day period or 16 hours for a 4-day period is required if the spraying round is to be postponed. Where plucking rounds are 9 or 10 days, as in many up-country estates, a 5-day period is convenient. For mid- and low-country estates, where plucking rounds are often 7–8 days, a 4-day period should be considered.

The only additional equipment necessary is a sunshine recorder, preferably for each division, and preferably of the Campbell-Stokes type. The cost, with sufficient charts for one year, ranges from Rs. 375/- to Rs. 730/-. Generally the cost of even the more expensive instrument is saved by the omission of only a single spraying round. Estates of 600 acres could afford to buy two recorders for two divisions.

The principle of this method was put into practice in 1959 on five estates on a limited field scale. The trials were carried out by the estates on the advice of the T.R.I.

Plan of the Experiment

The principle of each experiment was that an area of 25–50 acres was divided into four or five blocks of similar size. Each of these blocks was treated separately, according to the sunshine recorded. In other words, the decision whether to spray or not to spray a block on a particular day would be taken after finding the amount of sunshine recorded during the previous four or five days.

The five blocks would normally be sprayed on 5 consecutive days, so that the spraying of the whole experimental area would be completed in five days. If a spraying round was omitted on one block, it would be necessary to reconsider spraying that block after a further five days and not after ten days, as is usually done in connexion with plucking rounds. If the sunshine had again been sufficient, the spraying would again be delayed for a further five days. The system does not therefore involve omitting a whole round at a time, but delaying for five days (half a cycle) and then repeatedly deciding, after each five days, whether the amount of sunshine justifies a further 5-day delay. There is naturally a risk of doubling the amount of spraying to be done on certain days.

One estate omitted sprays for a whole division on account of five-day records taken during the second half of the plucking round. Although this involved a considerably greater risk, the results on this estate were still quite good. We can therefore assume that the limit of 20 hours sunshine per five days or 16 hours sunshine per 4 days, is still on the high side. This particular estate saved fewer rounds than the others partly due to the practice of omitting and not delaying rounds, and partly because it was located in an area where there was much mist, and therefore little sunshine.

Method of Assessment

The assessments of Blister Blight were done by the estates according to the method described below.

Each of the five blocks of a trial was assessed at 8–10 day intervals just before plucking, according to the plucking scheme for the five blocks. The assessor picked the points of assessment in the block at random by throwing a stick of about a yard in length at ten points. Around each point where the stick fell, 5 bushes were plucked, including the third leaf on the shoot. The total flush from 50 bushes per block was properly mixed and a sample containing approximately 200 shoots was taken from the heap. Whether a shoot was counted as infected or not was decided by the infection of the third leaf only. The third leaf of every shoot in the sample was then examined for signs of infection, varying from a translucent spot to mature spore-producing blisters. In order to detect the translucent spot, every leaf was examined against the light. Only the number of infected shoots was counted, not the number of blisters per shoot. After counting the number of infected and healthy shoots, the percentage infection was calculated.

Results

The results are given in Tables 2 to 6 and comments are added below.

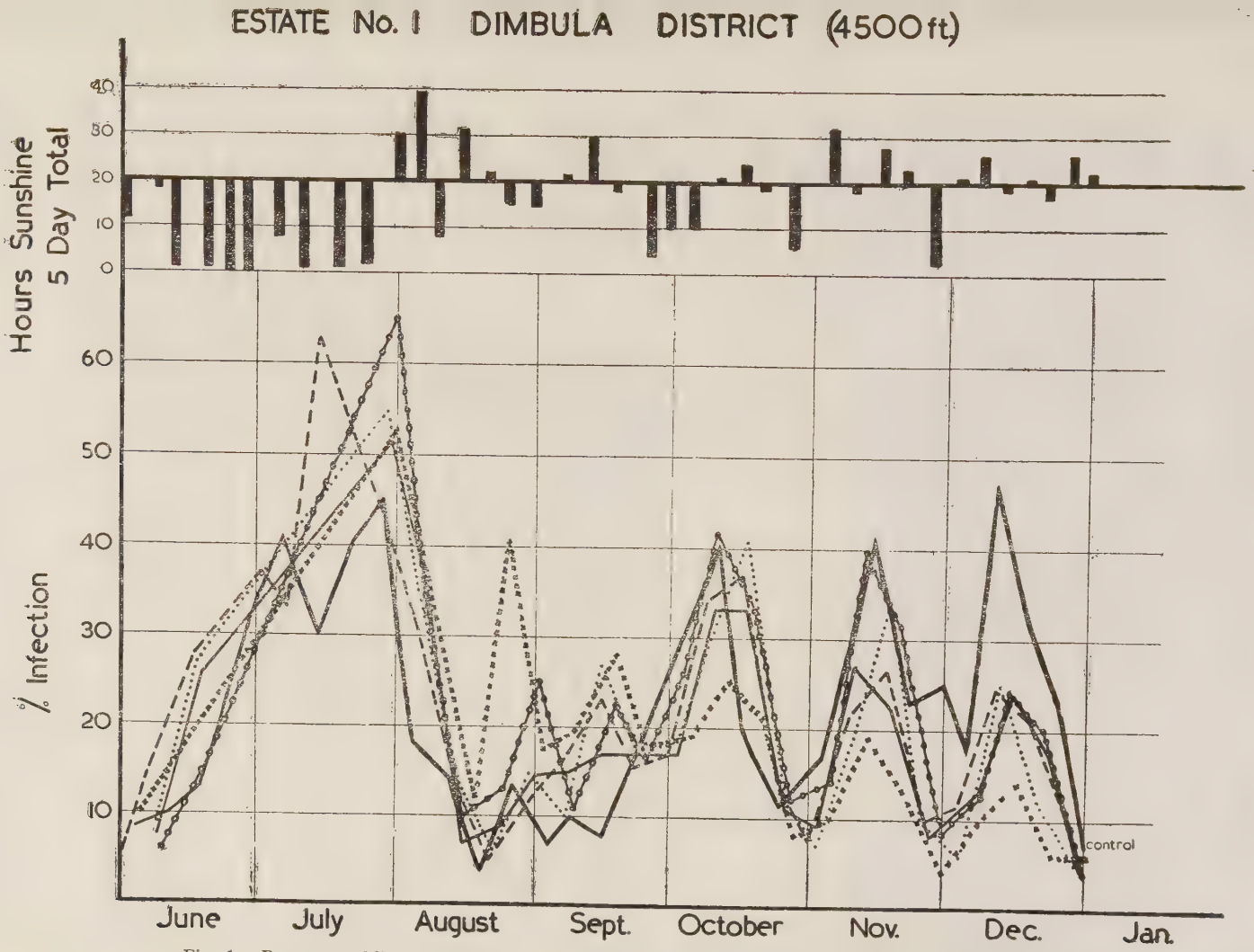


Fig. 1.—Percentage blister-blight infection from June to December, 1959, with the total sunshine for each 5-day period just before spraying was due. The various lines represent different blocks, the thick line representing the normally sprayed control.

Estate No. 1 in the Dimbula district (4,500 ft.)

In this trial the highest average monthly infection was 45% in July; this dropped to 25% in December.

The number of spraying rounds on the estate was 26, whereas the trial blocks were sprayed only 15–18 times.

The differences in infection between the different blocks cannot be regarded as significant. They are due to normal variations in severity of blister-blight infection at various spots in a field. Unfortunately, some blocks were not assessed during July.

TABLE 2.—*Estate No. 1. Dimbula District (4,500 ft.). Average percentage shoot infection and number of spraying rounds per month. Blister-blight forecasting system based on sunshine records for Blocks A—E, normal estate spraying for Block F (control)*

	Month	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Block	Average daily sunshine for each month	1 hr. 31min.	2 hr. 24min.	5 hr. 12min.	3 hr. 33min.	4 hr. 45min.	4 hr. 39min.	3 hr. 49min.	Total No. of rounds
A	% Infection	20.9	45.7	15.4	18.0	23.3	19.4	16.5	18
	No. of spraying rounds	3	4	3	3	2	2	1	
B	% Infection	18.1	—	17.0	18.2	25.3	17.6	11.9	16
	No. of spraying rounds	3	3	2	3	2	2	1	
C	% Infection	16.4	—	16.2	16.9	23.9	17.1	14.9	15
	No. of spraying rounds	3	3	2	2	2	2	2	
D	% Infection	13.2	—	18.5	18.1	27.9	23.2	16.2	15
	No. of spraying rounds	3	3	2	3	1	2	1	
E	% Infection	17.0	—	31.5	20.5	18.4	11.5	8.9	16
	No. of spraying rounds	3	3	2	3	2	2	1	
F	% Infection	10.6	37.9	12.3	11.4	22.6	26.9	25.3	26
	No. of spraying rounds	3	4	4	3	4	4	4	

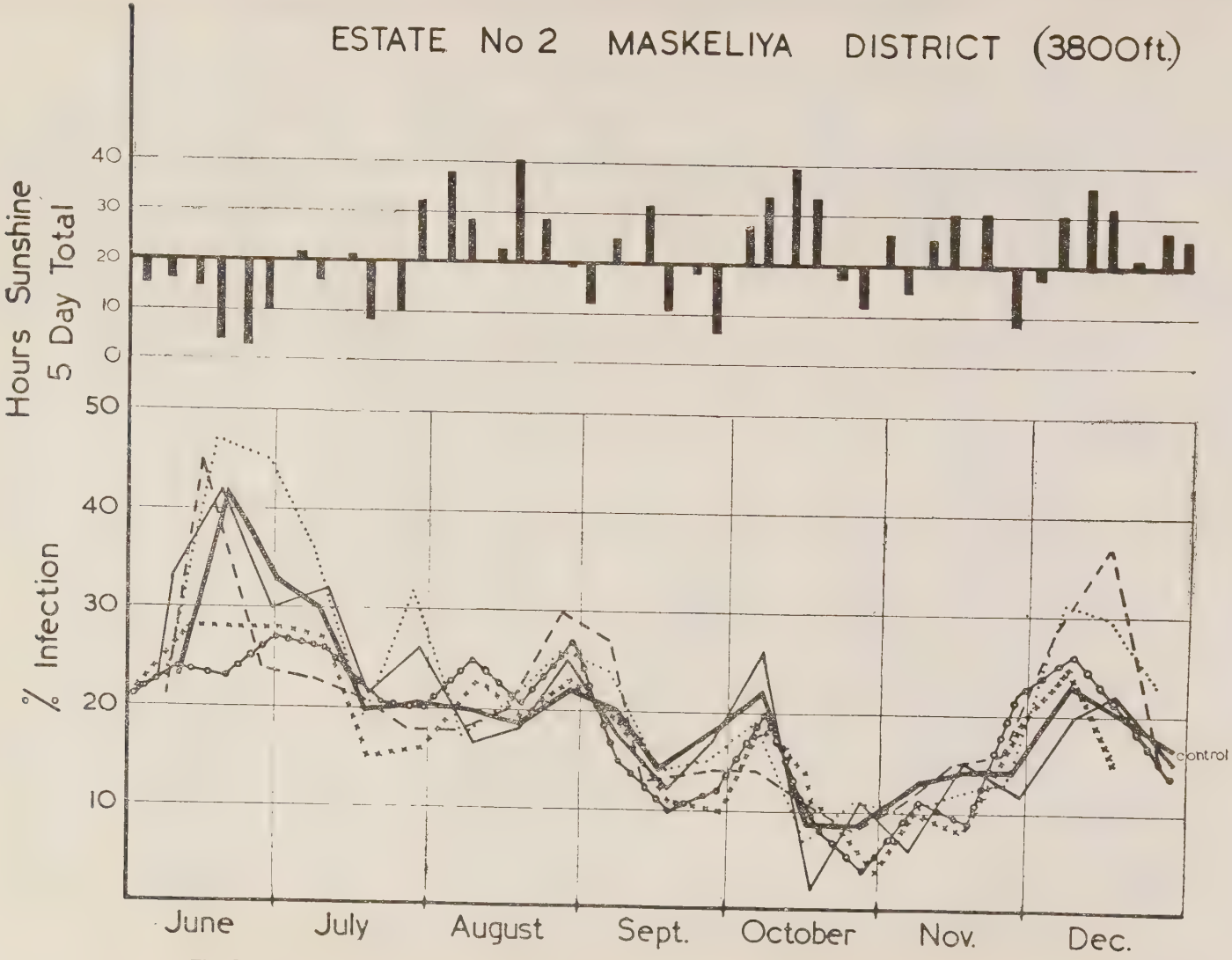


Fig. 2.—Percentage blister-blight infection from June to December, 1959, with the total sunshine for each 5-day period just before spraying was due. The various lines represent different blocks, the thick line representing the normally sprayed control.

Estate No. 2 in the Maskeliya District (3,800 ft.)

The number of spraying rounds was successfully reduced from 23 to 11–13 in the experimental blocks, without an appreciable increase in Blister Blight. On the whole, the infection was less severe than in the Dimbula District, the highest infection being 38% for Block B in June.

TABLE 3.—*Estate No. 2. Maskeliya District (3,800 ft.). Average percentage shoot infection and number of spraying rounds per month. Blister-blight forecasting system based on sunshine records for Blocks A—E, normal estate spraying for Block F (control)*

	Month	June	July	Aug	Sept.	Oct.	Nov.	Dec.	
Block	Average daily sunshine for each month	2 hr. 24min.	3 hr. 38min.	5 hr. 42min.	3 hr. 50min.	5 hr. 24min.	4 hr. 32min.	5 hr. 25min.	Total No. of rounds
A	% Infection	20	21	22	18	11	14	26	12
	No. of spraying rounds	4	2	1	2	1	2	0	
B	% Infection	38	29	21	17	12	11	28	11
	No. of spraying rounds	3	2	0	3	1	2	0	
C	% Infection	35	26	20	15	13	11	19	12
	No. of spraying rounds	3	3	1	2	1	2	0	
D	% Infection	24	22	24	9	11	14	21	13
	No. of spraying rounds	3	2	2	3	1	1	1	
E	% Infection	26	21	22	13	11	13	20	13
	No. of spraying rounds	3	2	2	3	1	2	0	
F	% Infection	34	23	20	17	13	13	20	23
	No. of spraying rounds	4	3	4	3	3	3	3	

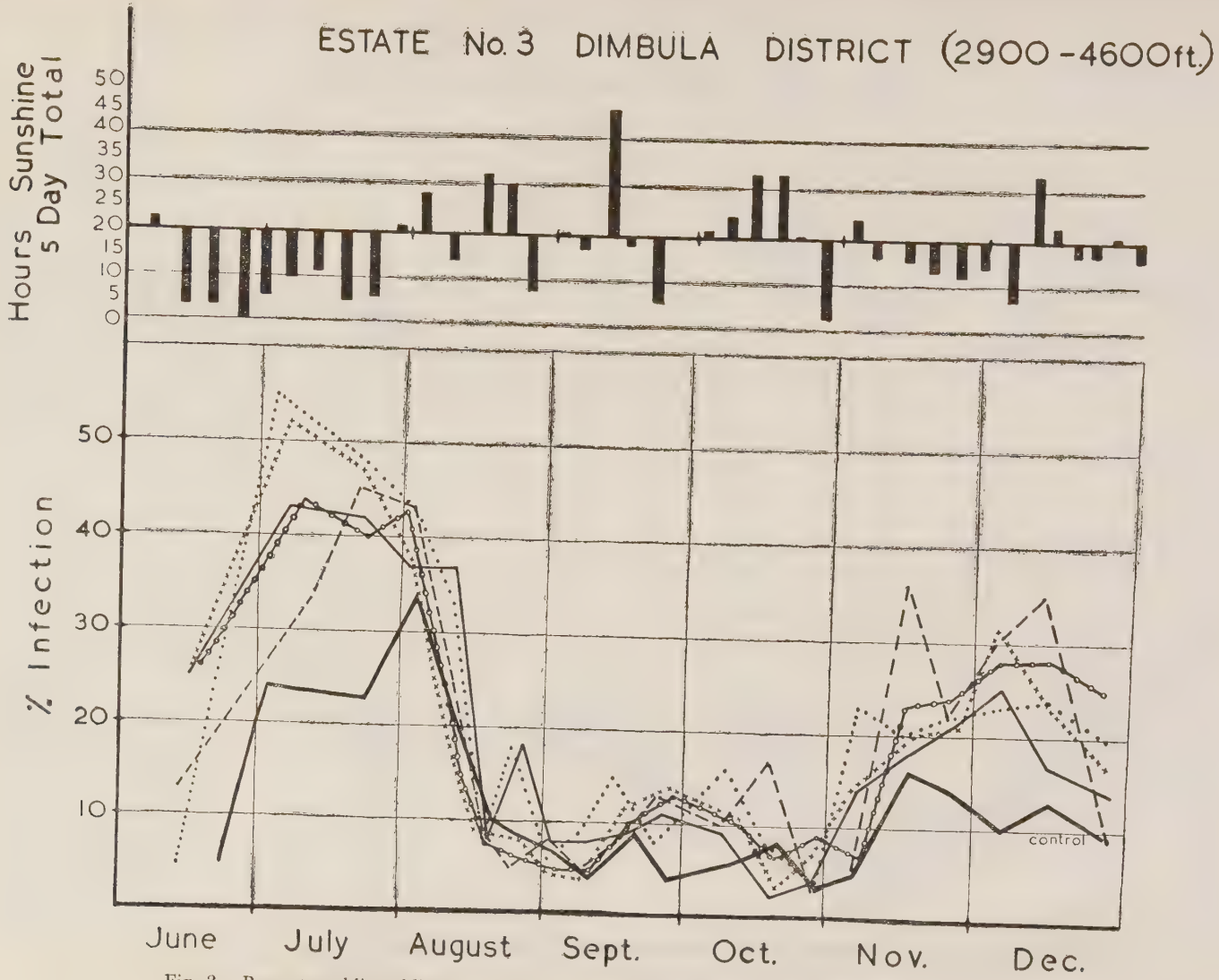


Fig. 3.—Percentage blister-blight infection from July to December, 1959, with the total sunshine for each 5-day period just before spraying was due. The various lines represent different blocks, the thick line representing the normally sprayed control.

Estate No. 3 in the Dimbula District (2,900—4,600 ft.)

On this estate the reduction in number of spraying rounds have given good results during August, September, October and November but during July and December the blister-blight infection went up in the experimental plots. The reason for this is that the plots sprayed according to sunshine had ten-day rounds, while the control block was sprayed every seven days.

TABLE 4.—*Estate No. 3. Dimbula District* (2,900 *ft.*—4,600 *ft.*). *Average percentage shoot infection and number of spraying rounds per month. Blister-blight forecasting system based on sunshine records for Blocks A—E, normal estate spraying for Block F (control)*

	Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Block	Average daily sunshine for each month	1 hr. 46min.	5 hr. 17min.	3 hr. 54min.	4 hr. 16min.	4 hr. 19min.	4 hr. 58min.	Total no. of rounds
A	% Infection	39.5	20.7	8.5	10.0	21.0	24.6	9
	No. of spraying rounds	2	2	3	0	1	1	
B	% Infection	51.5	25.5	9.5	9.3	4.7	23.5	11
	No. of spraying rounds	2	2	2	1	1	3	
C	% Infection	42.5	25.0	9.0	5.0	17.6	18.6	9
	No. of spraying rounds	2	2	2	1	1	1	
D	% Infection	41.8	18.5	8.2	8.7	17.6	23.3	9
	No. of spraying rounds	3	2	1	1	1	1	
E	% Infection	49.9	19.7	8.3	6.6	18.4	25.3	9
	No. of spraying rounds	2	2	2	1	1	1	
F	% Infection	23.5	17.6	6.0	6.0	11.1	10.6	16
	No. of spraying rounds	4	2	3	2	2	3	

Estate No. 4 in the Hewaheta District (3,260 ft.)

This area seems to be ideal for the saving of a considerable number of spraying rounds.

Infection remained low throughout the experiment, compared with the figures for the up-country estates.

The experimental blocks did not differ to any appreciable extent from the control block, which was sprayed with the rest of the estate.

Almost two-thirds of the spraying rounds were omitted during the five months of the experiment.

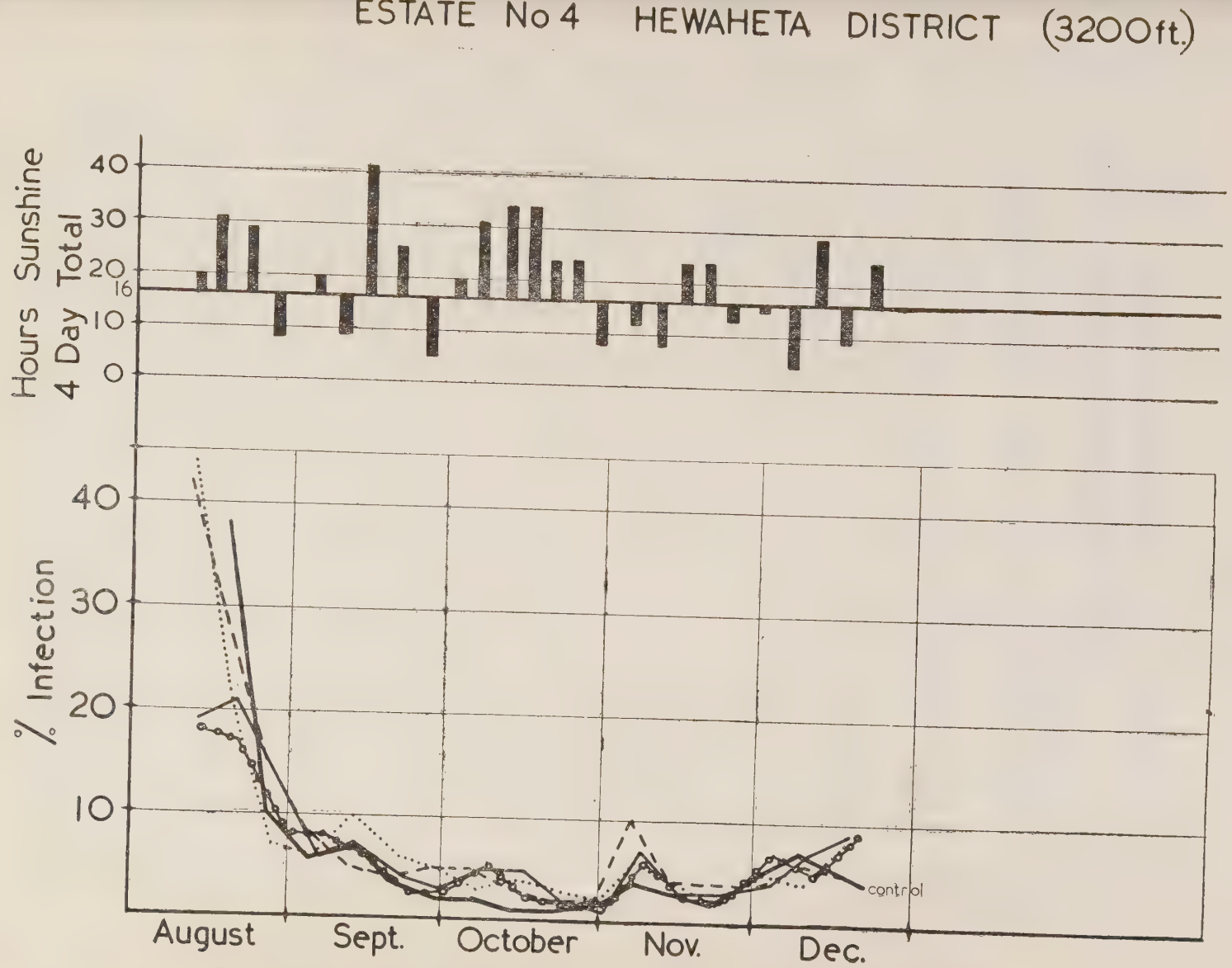


Fig. 4.—Percentage blister-blight infection from August to December, 1959, with the total sunshine for each 4-day period just before spraying was due. The various lines represent different blocks, the thick line representing the normally sprayed control.

TABLE 5.—*Estate No. 4. Hewaheta District (3,200 ft.). Average percentage shoot infection and number of spraying rounds per month. Blister-blight forecasting system based on sunshine records for Blocks A—D, normal estate spraying for Block E (control)*

	Month	Aug.	Sept.	Oct.	Nov.	Dec.	
Block	Average daily sunshine for each month	6 hr. 42min.	5 hr. 55min.	5 hr. 54min.	4 hr. 8min.	4 hr. 36min.	Total no. of rounds
A	% Infection	28.3	5.5	3.0	6.0	5.0	6
	No. of spraying rounds	0	2	1	2	1	
B	% Infection	24.0	6.7	3.0	4.0	5.6	6
	No . of spraying rounds	0	2	1	2	1	
C	% Infection	20.0	5.0	4.0	3.5	6.6	5
	No. of spraying rounds	0	1	1	2	1	
D	% Infection	14.0	5.6	3.2	4.0	7.5	6
	No. of spraying rounds	0	1	2	2	1	
E	% Infection	24.0	4.7	1.5	3.0	5.3	17
	No. of spraying rounds	3	4	3	4	3	

Estate No. 5 in Dimbula District (4,500—5,000 ft.)

Even in one of the worst blister-blight areas, the method proved to be reliable and useful even when used in a slightly modified way.

The result was very satisfactory because no increase in blister-blight infection arose from the reduction in the number of spraying rounds.

This trial differed from our lay-out of the experiment in that the decision to spray or not to spray, was taken once every five days for a whole division and not separately for fields of a division, or blocks in a field on consecutive days. Nevertheless, the highest infections recorded in the experimental area and in the control field were the same (44% in July).

TABLE 6.—*Estate No. 5. Dimbula District (5,500 ft.). Average percentage shoot infection and number of spraying rounds per month. Blister-blight forecasting system based on sunshine records for Blocks A—D, normal estate spraying for Block E (control)*

	Month	June	July	Aug.	Sept.	Oct.	Nov.	
Block	Average daily sunshine for each month	0 hr. 51min.	1 hr. 42min.	4 hr. 23min.	2 hr. 57min.	3 hr. 9min.	2 hr. 39min.	Total no. of rounds
A	% Infection	16.7	38.3	32.5	20.3	7.4	4.6	19
	No. of spraying rounds	4	4	2	3	3	3	
B	% Infection	17.3	34.6	11.5	19.6	6.1	4.0	17
	No. of spraying rounds	4	3	2	3	3	2	
C	% Infection	17.5	42.3	19.7	18.4	6.9	3.3	16
	No. of spraying rounds	4	3	2	3	2	2	
D	% Infection	11.5	41.3	17.5	17.3	6.9	5.1	18
	No. of spraying rounds	4	3	2	3	3	3	
E	% Infection	16.0	55.6	18.3	19.0	3.4	4.1	20
	No. of spraying rounds	4	4	3	3	3	3	

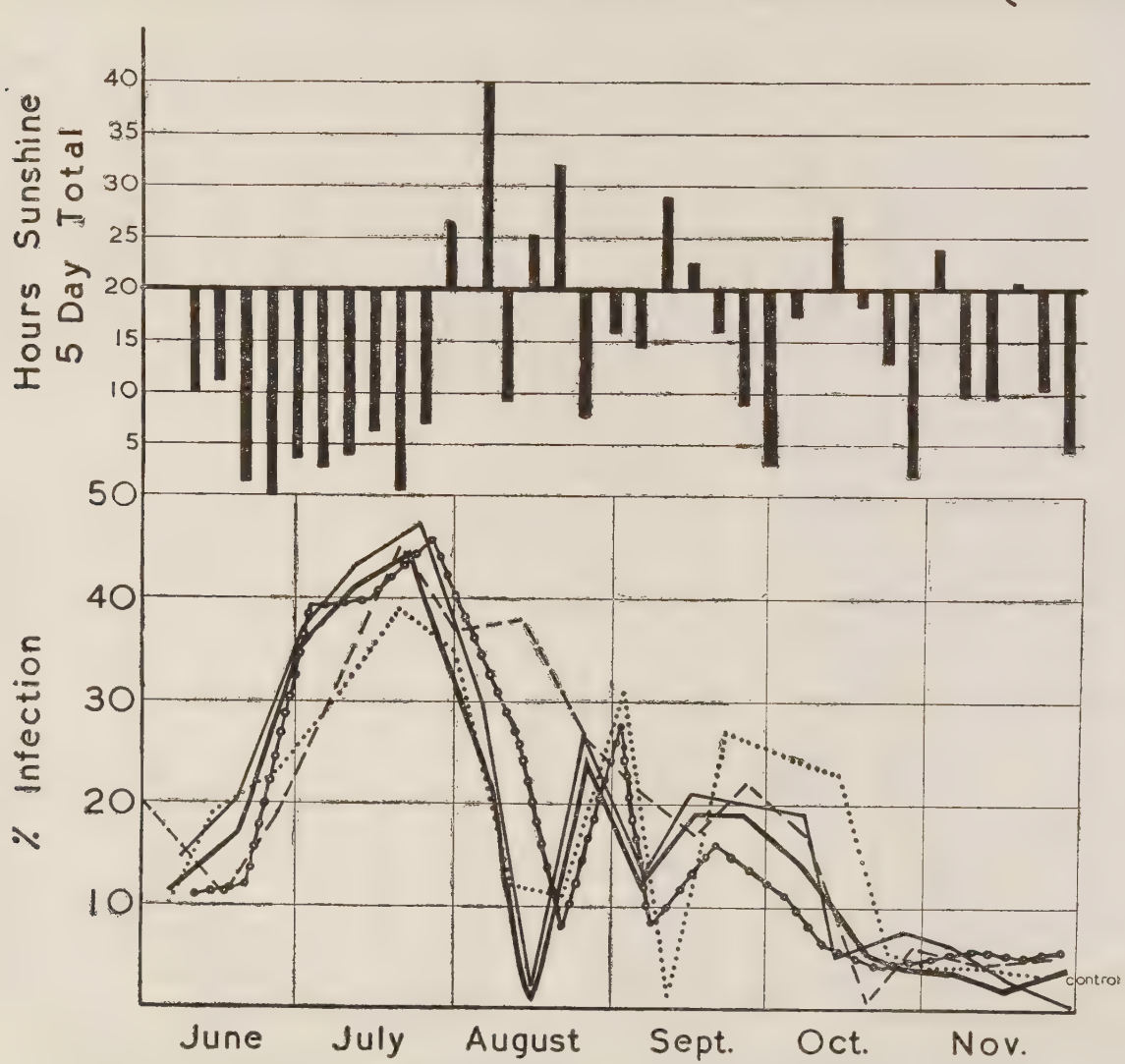


Fig. 5.—Percentage blister-blight infection from June to November, 1959, with the total sunshine for each 5-day period just before spraying was due. The various lines represent different blocks, the thick line representing the normal sprayed control.

Conclusions

The method of forecasting the necessity of blister-blight control, based on sunshine records of the foregoing five-day period, has been proved to be of considerable advantage on five estates.

TABLE 7.—*Summary of Trial Data*

Estate	Average no. of hr. sunshine for period of experiment	Average percentage infection		No. of routine rounds on estate	Average no. of rounds saved
		Expt.	Control		
No. 1	3 hr. 41 min.	17.0	21.0	26	10
No. 2	4 hr. 24 min.	19.3	20.0	23	11
No. 3	4 hr. 49 min.	20.5	12.5	16	7
No. 4	5 hr. 27 min.	8.2	7.7	17	11
No. 5	2 hr. 36 min.	17.5	19.0	20	2.5

Although there is good hope that this forecasting system will be generally applicable, any estate that wishes to save on blister-blight control, by reducing the number of rounds, should first try this method on a limited scale on a field or a division.

Acknowledgment

The co-operation of the five estates who carried out the experiments on their own account and their willingness to produce the figures for publication is gratefully acknowledged.

Thanks are also due to the estates who gave us the information on costs of blister-blight control.

References

1. MULDER, D. (1959). Report of the Plant Pathologist. *Annu. Rep. Tea Res. Inst. Ceylon for* 1958: 62-66.
2. VISSER, T., SHANMUGANATHAN, N., MULDER, D. (1959). The possibility of timing blister-blight spraying according to sunshine records. *Tea Quart.* **30**: 39-43.

A VISIT TO NORTH-EAST INDIA

D. Mulder

The Annual Conference of the Indian Tea Association was held at the Tocklai Experimental Station on the 17th, 18th and 19th of November, 1959. After attending this conference I spent a few days in Assam and went for a week to the Darjeeling district.

Annual Conference at Tocklai Experimental Station

Seventy-nine persons attended the conference, consisting of 39 members of the Indian Tea Association, 9 officials of organizations, 2 visitors from abroad, and 29 members of the staff of Tocklai, so roughly half of the conference consisted of planters.

The meetings of the conference consisted of three morning sessions dealing with "Pests and Diseases", "Pruning and Plucking", and "Engineering Development and Manufacture". During the first sessions, five papers were read, and discussions on fourteen questions and on the papers were held. During the second session, three papers were read, and discussions on 21 questions and on the papers were held. The third session was held in the pilot factory and consisted of demonstrations of new machinery and discussions on seven questions. Two afternoons were spent on demonstrations in the laboratory and the field. The organization was very efficient and a considerable amount of ground was covered.

The Red Spider Mite is a serious pest, threatening yields on many estates. Losses average 10% and, on an 800-acre estate, Dr Sen calculated the total loss to be 67,000 rupees per year. Control measures are hampered by the fact that several good acaricides cannot be used because of possible toxic residues in the made tea. Dr Das offered the method of complete defoliation after the yearly pruning is done in the autumn, as an alternative to chemical control during the plucking season. A winter spray can give added assurance.

Recently a new section has been set up under the name of "Pesticide Testing Unit" for the screening of new insecticides, acaricides, nematocides and fungicides. Trials done by this section showed that, of several acaricides, "Tedion" gives the best results. Endrin proved best against Looper Caterpillar. Colloidal copper with only 15% copper was just as good against Blister Blight as conventional formulations with 50% copper.

The Mycologist, Mr Sarmah, discussed the stimulatory effect of water-logging of the soil on diseases like Red Rust, collar rots (due to *Fusarium* and *Pythium*) in the nursery, and Violet Root Rot (*Sphaerostilbe repens*) in the gardens. The Chief Advisory Officer reviewed the situation and concluded that in the first place the primary object must be the removal of the predisposing factors. One of the main troubles regarding better control of pests and diseases is that, owing to import restrictions, the necessary equipment for spraying is very hard to obtain.

Dr Barua, the Physiologist, expounded the fundamental knowledge which had come to light from some interesting experiments and which provides us with much more insight into the physiological reactions of the bush to pruning and plucking. According to this research work, the ideal tipping level as regards yield is at 5 leaves above pruning level which, in the experiment, was equal to 6 inches above the prune. For a vigorous Assam type, it can be as high as 8–10 inches whereas with

a China type it may be only 4 inches. Barua explained that this optimal tipping level results from two opposing trends: (*a*) with a higher tipping level, the health and the vigour of the bush increase, as expressed by thickness of primary girth of main limbs, starch reserves, and weight of prunings; (*b*) with a higher tipping level, yield goes down because, although the yield per primary goes up with the higher tipping level, the number of primaries goes down with the rise in tipping level, owing to a reduction of the number of primaries that develop after tipping. The level of 5 leaves coincides with the first level at which many shoots go banji.

The practical side of the pruning, tipping and plucking problem was dealt with by Mr S. K. Dutta, the Agronomist. According to him, skiffing is in most cases a bad practice because it makes the bush more susceptible to pests and diseases, and in Assam skiffing should be resorted to only as a measure of rehabilitation. A deep skiff is to be preferred.

Practical observations regarding pruning and skiffing were given by Messrs. Macalpin and Grice. They were in favour of annual pruning as compared with skiffing in the Assam district. In Darjeeling, an undue rise of the plucking table, because too much is left on the bush during the rush period in spring, is in many cases the cause of loss of crop. Grice is therefore in favour of harder plucking in that area.

Of the many questions sent in before the Conference, a few were of more general character. The question of the value of soil stirring was answered by the Physico-chemist, Mr Gokhale, by emphasizing that in most conditions this practice should be avoided in established tea and that more attention should be given to green cropping, shade, and composting. The effect of sulphate of ammonia (the only artificial fertiliser applied on mature tea in Assam!) on the soil was discussed. Mr Gokhale made it clear that leaching out of magnesium and calcium results. I wondered whether this would not lead eventually to calcium deficiency on a soil which is already so low in calcium, and whether Rim Blight could be the result of a temporary calcium deficiency in spring shortly after manuring, referring to work of de Haan on symptoms of deficiencies in Indonesia. Mr Gokhale did not consider that temporary calcium deficiency was a possibility.

Mr Green replied to a question on the value of the phloem index (the number of calcium-oxalate crystals in a section of the phloem) for quality selection, and said that he found a clear relation between the P.I. and the quality of the made tea in 10 out of 12 bushes selected for a high P.I. According to him, pigmentation had not shown any promise as a criterion yet.

Impressions of Darjeeling District

During the stay in the Darjeeling area, Mr W. Grice, Advisory Officer of the Indian Tea Association, very kindly arranged trips to three estates and offered transport and companionship during these days. I would like to take this opportunity of acknowledging his help, which made our stay in Darjeeling such a pleasure.

Tea growing in this district is in several ways similar to that in the up-country of Ceylon, but the differences are also apparent.

The tea is mainly a strongly China type and grown on small one-row terraces with grass strips in between, if the slope is steep. In general, slopes are steeper in Darjeeling than in Ceylon. This is because the mountain formation is much younger than in the centre of Ceylon.

At the time of the visit, growth had already stopped because of low winter temperatures, and one factory which I visited had just closed down.

The purpose of my visit was mainly to see whether any symptom of Phloem Necrosis virus disease was apparent. Several areas were closely examined but no necrosis in the petiole could be detected. One area, which had been pruned almost a year ago and showed one season's growth, was ideal for symptom development and was inspected carefully. No suspicious symptom was found, however,

the only discovery being a plant showing a white variegation on the lower leaves of several shoots. This occurrence of symptoms only on the lower leaves suggested an influence on symptom expression of the rise in temperature during the growing season. Such an influence is understandable if the cause of the variegation is a virus.

Although the weather was very nice throughout my stay in Darjeeling, November is not the right time for a visit in connection with tea culture because growth has come to a standstill, and the bushes have a dull, dark green colour with plenty of signs of blister-blight infections and scale insects. Weeds are controlled only once a year; this practice leads to an almost closed cover of weeds at the end of the growing season. This is certainly a help in the control of soil erosion and the upkeep of a good organic matter content in the top soil. No symptoms of deficiency diseases could be observed in China tea. This is probably because much less fertilizer is applied than in Ceylon and the yields are rather low. On a pear tree, however, clear symptoms of magnesium deficiency were found, which shows that there, too, the magnesium content of the soil is marginal.

Altogether, four estates were visited. They all showed a fair amount of Blister Blight and it was explained that no blister-blight spraying was done because during the rush period in spring time no control measure could be taken. Owing to the shortage of labour at that time, no one was available. Under such circumstances, dusting large areas with petrol-powered dusters would be the most suitable method but this has not been developed yet, owing to import difficulties. At the end of the growing season the spraying against insects is stopped and this had at one estate led to a bad attack of a scale insect, which caused a lot of Sooty Mould.

The only fungus that is troublesome apart from Blister Blight seems to be *Aglaospora aculeata*, causing Thorny Stem Blight, which is rare in Ceylon. Some Thread Blight (no latin name of fungus) and Black Rot (*Corticium sp.*) was found to occur on one estate.

The vegetative propagation method is becoming important for Darjeeling, as it is for Ceylon. Owing to the low temperature during more than half of the year, it was found profitable to grow the cuttings in makeshift greenhouses of plastic and bamboo, which probably last only one season. The advantages are not only higher temperatures but also constant high humidity of the air.

In order to avoid too high temperature, the plastic roof was protected against the sun by a second roof of jute hessian expanded over bamboo beams. In such a temporary greenhouse, thousands of cuttings can be grown and easily inspected for occurrence of diseases and pests. In a second greenhouse, the slightly-rooted cuttings were grown in pressed earth pots for distribution in the field. The advantage of these six-sided earth pots is obvious, compared with the usual baskets or the modern plastic bags, which always leave holes in between on the corners.

The usual way of growing cuttings in Northern India, as I saw it both in Assam and in Darjeeling, is under bamboo slats, which are about 6 inches above the ground. On one estate all new planting was done with clonal material of china, hybrid, and Assam types. The types with big leaves showed some symptoms of magnesium deficiency. The planting was done on small terraces but the rows were orientated down the slope, crossing the terraces and crossing the rows of *Crotalaria* which had been sown earlier. The *Crotalaria* showed, both in Assam and in Darjeeling, a fairly severe attack by a virus disease that also occurs in Ceylon.

Both in Assam and in Darjeeling, it is remarkable that very few abnormalities such as yellow and white variegation, mottle leaf, white and red speckle leaf, little leaf, vein-clearing, vein-banding, etc. occur. Both virus disease symptoms and genetic abnormalities seem to be extremely rare. I was tempted to believe that this is mainly due to a better selection of the seed and perhaps also because tea in India is, generally speaking, not of a hybrid nature, but either Assam type or China type.

Conclusion

Tea culture in N.E. India covers a much wider range of climate than in Ceylon because both tropical and temperate climates are included, and the variation in soil types is also bigger; in both Assam and Darjeeling there is a dormant season. This poses problems of research to the station in Tocklai which are unknown in Ceylon.

The Conference showed that research is certainly not the limiting factor for the development of the industry in India, but that, on the contrary, both in pest control and in manufacturing, the Experimental Station is well ahead of practice.

Acknowledgment

My sincere thanks are due to the Director of the Tocklai Experimental Station, Mr H. Ferguson, for providing the opportunity of attending this Conference and for hospitality throughout the trip.

References

Barua, D. N. (1960). Plucking in relation to pruning: some physiological principles. *Two and a Bud*, **7**: 3–8.

Dutta, S. K. (1960). Experiments on pruning and tipping in relation to plucking and yield. *Two and a Bud*, **7**: 9–21.

Eden, T. (1936). Report on a visit to the tea districts of North-East India, 1935 *Bull. Tea Res. Inst. Ceylon*, no. 14: 42 pp.

Eden, T. (1958). Tea. (*Longmans, Green & Co., London*, 201 pp.).

Kehl, F. H. & Keegel, E. L. (1959). Report on visits to North-East and South India. *Tea Quart.*, **30**: 71–85.

Macalpine, R. I. & Grice, W. J. (1960). Pruning and tipping measures in practice. *Two and a Bud*, **7**: 22–27.

SHOT-HOLE BORER (*Xyleborus fornicatus* Eich.) AND CLONES

E. Judenko

Introduction

There are several ways of killing a pig; and shot-hole-borer damage could be avoided if we had a clone of tea that the insect could not damage. Although it is unlikely that we can find a bush that is not attacked at all, it is worth looking for because it would be so valuable if it could be found. Even if an immune bush gave a poor yield or poor tea, it might be possible to recombine its immunity by cross breeding.

Complete immunity is not the only property worth discovering; as Hutchinson (1960) has pointed out for eelworms, resistance to attack, without complete immunity, would be useful too, and is more likely to occur. Tolerance, which permits active attack but without noticeable harm, would also be worth finding.

The work described here has been limited in several ways: it is confined to clones and does not deal with seedling tea; there are not yet enough substantial areas of many clones in shot-hole-borer areas to give anything like a complete picture; and the sampling has had to be done in the limited time available between long-period experiments. It is not claimed that a fair comparison has been made between clones; for that, clones under test would have to be equally exposed to infection at each of a number of climatically different sites (Painter, 1951). Such investigations will become possible when the clonal plots are well advanced in various places.

Method of Assessment

The standard-unit method (Judenko, 1958) was used, in which the numbers of shot-hole-borer galleries in 50 standard units are assessed. This method is rough and could be improved upon, but it is quick.

Results

We examined 67 samples from 37 clones, of ages varying from 2 to 11 years from planting, on 21 estates at elevations of 120—3,800 feet (Table 1). Some of the data have been published previously (Judenko, 1958*a*).

Some of the places investigated were not close to tea infested with Shot-hole Borer but were separated by jungle or rubber; in these cases, a small number of galleries may be due to comparative absence of initial infestation rather than to any degree of immunity or resistance, so such isolated areas are marked in the table as "*Isol*".

In all cases, Superintendents were asked about the yield of the tea examined; where they said it was unsatisfactory, that opinion is recorded in the table as "*Unsat.*". In some cases (marked "?") yield information is not available. In all the other cases in the table, the yields were regarded as satisfactory.

It is at once notable that the isolated areas had low infestations: in 14 such samples, there were 10 with no galleries compared with only one out of 53 in non-isolated areas; in the remaining 4 isolated areas the numbers were always low (1, 2, 6, 1). Clearly the proximity of other (infested) tea is of such importance that

TABLE 1.—*Incidence of shot-hole-borer galleries in some tea clones*

Number in order	Elevation: feet	Estate	Clone	Age: Years	Number of galleries per 50 standard units	Remarks
1	120	Palmgarden	TRI 2023	5	0	
2			TRI 2026	5	7	
3			TRI 37	5	7	Unsat.
4			TRI 25	5	27	
5			G.K. 518	5	43	
6	400	Niriella	TRI 2025	4	0	Isol.
7			TRI 2026	4	0	Isol.
8			TRI 2024	4	1	Isol.
9	400	Millawitiya	TRI 2023	3 & 5	2	
10			TRI 2026	2 & 5	14	
11	600	Niriella	3—B 22	8	107	
12			1—B 7	8	111	
13	700	Pelmadulla	TRI 25	3	0	Isol.
14			TRI 2023	3	0	Isol.
15			TRI 2024	3	0	Isol.
16			TRI 2026	2	2	Isol.
17			Nil. 12	4	6	Isol.
18	950	Karandupone	TRI 2023	2	3	?
19			TRI 2026	2	15	?
20			TRI 2024	2	16	?
21	1,000	Wellandura	Wellandura 34	8	2	
22	1,000	Endane	Endane 31	3	2	
23			Endane 30	3	9	Unsat.
24			Endane 28	3	10	
25			Endane 23	3	25	
26	2,000	Kenilworth	Kenilworth 16/3	5	65	
27			Kenilworth 16/3	3	67	
28	2,200	Somerset	S.S. 1	5	14	
29	2,200	Palamcotta	TRI 2026	4	139	
30	2,500	Enselwatte	TRI 2024	5	0	Isol.
31	3,000	Craighead	C. H. 13	3 & 7	11	
32			C. H. 13	5	24	
33			TRI 2024	5	47	
34	3,200	Delta	S/4/63	3	8	Unsat.
35			S/4/51	3	28	
36			S/4/40	3	42	
37			TRI 2024	Ab. 3 yrs.	49	
38			S/4/25	3	60	

(*Continued on page.* 74)

TABLE 1. *(contd.)—Incidence of shot-hole-borer galleries in some tea clones*

Number in order	Elevation: feet	Estate	Clone	Age: Years	Number of galleries per 50 standard units	Remarks
39	3,200	Enselwatte	TRI 2023 •	2	0	Isol.
40			TRI 2024	2	0	Isol.
41			TRI 2026	2	0	Isol.
42			TRI 2025	2	1	Isol.
43	3,300	Enselwatte	TRI 2016	2	0	Isol.
44	3,300	Queenstown	TRI 2023 •	8	7	
45			Q.T. 2/5	11	35	
46			Q.T. 4/4	11	67	
47	3,500	Pettiagalla	TRI 2023 •	7	4	
48			Pettiagalla 13-B	4	5	
49			Pettiagalla 11-2	6	8	Unsat.
50			TRI 25	5	44	
51	3,500	Ravenscraig	TRI 2024	5	28	
52	3,500	Balangoda	D. G. 7	7	46	
53	3,600	Dickwella	U. D. 2/1	9	32	?
54			Q. T. 2/3	6	34	?
55			Q. T. 4/4	6	36	?
56			L. D. 4/1	9	51	?
57			L. D. 6/1	9	65	?
58	3,700	Gonakelle	TRI 2023 •	3	3	
59			TRI 2022	5	26	
60			TRI 2024	5	28	
61			T. S. 35	5	52	
62			P. D. 13	5	59	Unsat.
63			TRI 1526	5	68	
64			TRI 1294	5	93	Unsat.
65	3,700	Downside	TRI 2024	3	90	
66			TRI 2025	3	126	
67	3,800	Hugoland	TRI 2026	2	9	

lack of infestation in isolated areas cannot be regarded as giving any information at all about resistance (cf. Cowling, 1956). In this class TRI 2016 had no galleries, but a single examination in an isolated place cannot be regarded as even indicative, especially as TRI 2024 and TRI 2026, which appear to be rather susceptible (see next paragraph), gave 5 zeros in 7 samples.

Of the 26 estate clones not in isolated areas, only three were sampled more than once and none of the pairs gave very promising results. A few of these estate clones gave low figures on a single sample and might be worth further investigation for resistance. Of the 9 T.R.I. clones, only TRI 2023 gave consistently low numbers in six samples from different estates, while TRI 2024 was consistently high. TRI 2026 might have been regarded as consistently moderate but for the infestation of 139 at Palamcotta. Even in these two cases (TRI 2024 and 2026) the yields were not considered unsatisfactory and these clones may be tolerant; alternatively, their productivity may be so high compared with other clones that even if reduced by Shot-hole Borer, it is still satisfactory. It is not unequivocally demonstrated yet, however, that Shot-hole Borer does reduce yield, at any rate over a short period.

Summary

1. None of the 35 clones examined from non-isolated places up to 3,800 feet A.M.S.L. was free from shot-hole-borer galleries; in most cases the data are inadequate to say more than this.

2. Clone TRI 2023 was only lightly infested in 6 independent examinations on different estates. It is not immune but may be resistant.

3. Clone TRI 2024 was consistently heavily infested but seems to have yielded satisfactorily; it may be tolerant. TRI 2026 was generally (not always) less heavily infested and it, too, may be tolerant, with some resistance.

Acknowledgments

I thank Superintendents of the estates concerned for facilities afforded for examining their clones; and I thank my assistant, Mr Shanmugam, for his part in the work.

References

Cowling, D. L. (1956). Symposium on Shot-hole Borer. Views of Sabaragamuwa Planters' Association. *Tea Quart.*, **27:** 125–126.

Hutchinson, M. T. (1960). Resistance and tolerance of tea to nematodes. *Tea Quart.*, **31:** 13–18.

Judenko, E. (1958). Trials with a method of assessment of infestation caused by Shot-hole Borer (*Xyleborus fornicatus* Eich.) an old tea. *Tea Quart.*, **29:** 51–59.

Judenko, E. (1958*a*). Annual report of the Entomologist, Special Research, for 1957. *Bull. Tea Res. Inst. Ceylon*, no. 39: 57–59.

Painter, R. H. (1951). Insect resistance in crop plants. (*Macmillan, New York*, 520 pp.).

COPPER IN CEYLON TEAS

M. S. Ramaswamy

Copper is one of the elements essential to the normal functioning of life processes; its role in the formation of haemoglobin in the liver of vertebrates and in the cell respiration of plants is well known. The activity of a number of oxidising enzymes* isolated from vegetable sources is prevented in the absence of this element in the enzyme system. Tea polyphenol oxidase belongs to this group of enzymes and consequently enzymic copper in tea leaf is essential for the oxidation of tea polyphenols during fermentation. A direct relationship has been found to occur between the amount of enzymic copper and the rate of fermentation (Norris, 1944). Purified enzyme preparations have also shown a direct relationship between their activity and the copper content (Sreerangachar, 1943).

Stage of purification		*Polyphenol oxidase activity relative to green leaf*	*Copper content of the enzyme preparations (p.p.m.)*
1	...	151	32
2	...	330	60
3	...	3100	267
4	...	5060	625
5	...	10100	800

It has been found that in Ceylon teas about a third of the total copper in the leaf is present in the polyphenol oxidase. Teas deficient in enzymic copper do not ferment properly. Regular spraying of copper on the tea bushes is being carried out in parts of Nyasaland to make good a deficiency in this element.

As a matter of interest a non-fermenting clone (TRI Clone 9) has been propagated by the Plant Physiology Division of the T.R.I. and this has been found to be deficient in enzymic copper. The physiological characteristics of this clone are such that it is incapable of absorbing sufficient copper from the soil for the formation of the copper-protein enzyme, polyphenol oxidase. Injection of copper to the bush, or dipping the shoots in copper sulphate solution, increased the enzyme content, sometimes by five or six times, depending upon the concentration of the copper sulphate solution and the period of dipping. Fermentation of the treated leaf was then found to be normal, but the infusions were green due to the absorption of copper by the chlorophyll. Copper in the chlorophyll increased from the normal 5 up to 32 parts per million (p.p.m.). It is notable that addition of inorganic copper to the crushed leaf had no effect on fermentation, and evidently copper must be absorbed by the living cell if the copper-protein enzyme is to be produced. (Norris, 1944; Lamb, 1945).

**Enzyme.* If coal gas and air are mixed, normally nothing happens unless high-temperature heat is applied—a flaming match or a hot glowing wire; but a small area of platinum black, cold, will ignite the mixture. The platinum black is a *catalyst.* An *enzyme* is a sort of biological catalyst. All chemical activities in animals and plants are mediated by enzymes, from the building-up of starch in leaves to the energetic display of a champion hurdler. There are many different kinds of enzymes—all produced within living animals and plants. They are themselves complex chemicals and none have yet been made by non-living processes.

Analyses for copper content of tea flush from a number of clones propagated at the T.R.I. showed a variation between 16 and 30 parts per million (Lamb, 1948). The buds contain more than the leaves, whilst the stalks contain the least amount of copper.

Parts of the flush	*Copper content (p.p.m. dry wt.)*
Bud	33
1st Leaf	25
2nd Leaf	26
Stalk	19

This variation in the copper content of the parts of the flush is reflected in that of the various grades of tea. The fannings grade which contains most bud and least stalk, shows the highest amount of copper.

Grade of made tea	*Copper content (p.p.m. dry wt.)*
B.O.P.	24
F.P.	24
B.P.	24
B.M.	24
B.O.P. Fannings No. 1	31
B.O.P. Fannings No. 2	31
Dust No. 1	30

The copper content of made teas from different tea-producing countries varies considerably. The results of analyses of different grades and blends of tea available in the T.R.I. collection of foreign tea samples are shown below:

Tea producing country/Blend	*Copper content (p.p.m. dry wt.)*
North India-Assam, B.O.P. ...	31
North India-Assam, Fair B.P.	35
South India-Travancore, Good B.O.P. ...	34
South India-Travancore, Fair B.O.P. ...	31
Ceylon, Good B.O.P.	19
Ceylon, Fair B.O.P.	26
Japan, Low Black	62
Formosa, Good Oolong	18
Nyasaland, Average B.P.	25
Nyasaland, Good B.O.P.	24
Brooke Bond's blend	32
Co-op. special blend	27

During manufacture, the copper content of teas increases slightly, particularly during the rolling process because of contamination from the brass fittings. The increase is very much less in wooden rollers (with only a few brass parts) than in brass rollers (consisting of brass jacket and table).

Stage of Manufacture		*Copper content (p.p.m. dry wt.)*	
		Wooden rollers	*Brass rollers*
Withered leaf	...	23	23
1st Dhool	...	24	33
2nd Dhool	...	24	34
3rd Dhool	...	23	37
4th Dhool	...	25	34
Fired Tea (Bulk)	...	27	34

About a quarter to a fifth of the copper (inherent) present in made tea is soluble in the 5-minute brew, representing 0.09 to 0.12 parts per million of copper in the liquor.

Sample No.	*Copper content of tea (p.p.m. dry wt.)*	*Solubility of copper in the 5 min. brew*	*Copper content of the tea liquor (p.p.m.)*
1	26	22.0%	0.09
2	27	24.4%	0.11
3	30	21.0%	0.10
4	34	21.5%	0.12

Since the introduction of copper fungicides spraying for Blister Blight, copper residues have inevitably found their way into made tea. The authorities of some importing countries (notably the U.K. and U.S.A.) will not permit more than 150 p.p.m. of *total copper* in made tea. Routine analyses of made tea are carried out by the Government Analyst, Colombo, and the following table summarises the results from February, 1953, to November, 1959.*

Range copper content in (p.p.m.)	*Tea samples falling within the range*	
	Number	*Percent of samples*
0— 10	4	0.3
11— 20	22	1.5
21— 30	75	5.1
31— 40	165	11.2
41— 50	214	14.5
51— 60	239	16.2
61— 70	212	14.4
71— 80	184	12.5
81— 90	142	9.6
91—100	91	6.2
101—110	62	4.2
111—120	37	2.5
121—130	14	1.0
131—140	4	0.3
141—150	3	0.2
151—160	2	0.1
161—170	1	0.1
171—180	3	0.2
181—190	0	—
191—200	1	0.1

It may be seen from the above results that over 90% of the tea samples showed a copper content of less than 100 p.p.m., while over 99% of the samples contained less than 150 p.p.m. copper. It should, however, be stressed that whenever the

* By kind permission of the Tea Control Department, Colombo.

copper content of any particular invoice rises above 100 p.p.m., the estate concerned is informed and is advised to bulk such teas with teas of lower copper content so as to bring the copper content of the bulk to below 100 p.p.m. It would of course, be very unusual for one invoice to be packaged without a great deal of blending.

Although the spraying operations are carried out during the heavy monsoon season, and therefore most of the sprayed copper is washed off by rain, a fraction of it is always tenaciously held by the leaf. It has been found that even when the leaf is sprayed with soluble copper salts (*e.g.* copper sulphate), and immediately washed thoroughly with water, a fraction of the copper is still held by the leaf.

Treatment	*Copper content (p.p.m. dry wt.)*
1. Control	17
2. Leaf sprayed with copper sulphate and immediately washed thoroughly with distilled water ...	27
3. Leaf sprayed with copper sulphate but not washed	86

The exact nature of this capacity of the tea leaf to retain copper is still not known. Results of preliminary experiments have however indicated that chlorophyll takes up part of the copper to form copper-chlorophyll. Pectic substances in tea leaf are also likely to combine with copper to form copper pectate.

It has been shown earlier that about 20 to 25 per cent of the copper present in teas made from unsprayed leaf passes into the liquor; the solubility of the copper (inherent plus the residual) present in teas made from sprayed leaf (copper fungicides), on the other hand, showed a variation between 7 and 27 per cent, depending upon the strength of the brew and the copper content of the made tea. The per cent solubility was not affected appreciably by the period of brewing, between 5 and 30 minutes. A few typical solubility results are shown below:

Amount of copper which enters the liquor with weaker tea (2.7g in 170 ml.) and stronger tea (3.7g in 170 ml.), with black tea containing various proportions (p.p.m.) of copper and therefore various amounts (micrograms) per brew.

Brew	*p.p.m.*	*Micrograms per brew*	*Micrograms in the liquor in 170 ml. (one cup)* 5 & 10 *min.*	15 & 30 *min.*
Weaker ...	222	599	114	111
	160	432	60	55
	111	300	52	49
	44	119	32	30
Stronger ...	222	821	132	108
	160	592	45	43
	111	411	48	41
	44	163	31	29

The stronger brew does not contain more copper than the weaker, but when the black tea has more copper in it, more got into the liquor. This is somewhat mysterious, but in any case, the largest amount found was 0.8 p.p.m. In fact, of course, the black tea must not have more than 100 p.p.m. which gives about 0.3 p.p.m. in the liquor. This is lower than in other ready-to-drink beverages such as cider, beer, stout (0.5 to 2.0 p.p.m. copper), and wines (2 to 10 p.p.m. copper). It is of interest to compare this low copper content of tea liquors with that found in many food products which are consumed either partly or wholly:

Food product		*Copper (p.p.m.)*	*Reference*
Banana	...	2.0	(Nicholls, 1945)
Cereals	...	3.5	do.
Cheese	...	0.2	do.
Chestnuts	...	6.0	do.
Chocolate (bitter)	...	26.7	(Winton & Winton, 1939)
Cocoa	...	33.4	do.
Coconut	...	7.0	(Nicholls, 1945)
Coffee	...	24.0	(Winton & Winton, 1939)
Eggs	...	2.5	(Nicholls, 1945)
Fish	...	2.0	do.
Fruits	...	1.0	do.
Fruits (dry)	...	3.5	do.
Honey	...	2.0	(Winton & Winton, 1939)
Liver (Beef)	...	44.0	(Nicholls, 1945)
Liver (Calf)	...	22.0	do.
Meats	...	1.5	do.
Milk	...	0.2	do.
Nuts	...	12.0	do.
Oysters	...	30.0	do.
Poultry	...	3.0	do.
Pulses	...	7.0	do.
Vegetables	...	1.0	do.

In conclusion, copper, which is one of the essential elements for the life processes of vertebrates and higher plants, is required for the formation of the copper-protein enzyme in tea leaf responsible for the oxidation of tea polyphenols during fermentation. The amount of copper consumed in tea liquors is very minute and not likely to be injurious to human health; on the contrary it is likely to be beneficial.

References

Lamb, J. (1945). Annual report of the Biochemist for 1944. *Bull. Tea Res. Inst. Ceylon*, no. 26: 53–62.

Lamb, J. (1948). Annual report of the Biochemist for 1947. *Bull. Tea Res. Inst. Ceylon*, no. 29: 45–55.

Nicholls, L. (1945). Tropical Nutrition and Dietetics. 2nd Edn. (*Bailliere, Tindall & Cox, London*, 370 pp.).

Norris, R. V. (1944). Annual report of the Biochemist for 1943. *Bull. Tea Res. Inst. Ceylon*, no. 25: 52–58.

Sreerangachar, H. B. (1943). Studies on the 'Fermentation' of Ceylon Tea. VII. The prosthetic group of tea oxidase. *Biochem. J.*, **37:** 667–674.

Winton, A. L. & Winton, K. B. (1939). The structure and composition of foods, Vol. 4. (*John Willey & Sons, Inc., New York*, 580 pp.).

LETTERS TO THE EDITOR

SOME RESULTS OF VEGETATIVE PROPAGATION WITH TRI 2026

The T.R.I. Vegetative Propagation Officer, Mr F. H. Kehl, has repeated your request for data about some of my plantings at Berubeula Estate in Morawak Korale.

The area under TRI 2026 is 9,129 sq. ft. (33½ perches); with drains occupying 855 sq. ft., the total is 9,984 sq. ft. (36½ perches), in which there are 1,071 plants. It is divided into four blocks.

Block 1.—Cuttings from Palmgarden were put out in our nurseries in January, 1956, and planted from there direct into the field in August, 1956, at a spacing of 4′ × 2′. Part of the block was set out at 3′ × 3′ with plants from Palmgarden in April, 1956.

Blocks 2, 3, 4.—The cuttings were put into our nurseries in April, 1956; the three blocks were trenched and planted at 4′ × 2′ in September, 1956. The plants were removed from the nursery to the field in zinc cylinders. All the plants were bent and pegged down, in some cases two or three times, as long as there was no overlapping.

Manuring.—At three-monthly intervals, 1 oz. of Sterameal per bush for the first year; then half-and-half Sterameal and T. 180 at the same rate. After plucking began, 1½–2 oz. of T. 500, with alternate applications mixed with animal meal. Dolomite was also applied.

The first cuttings were taken (from the area planted in April, 1956) in March, 1957; during 1957, over 75,000 cuttings were obtained from the whole area. These cuttings were used for planting up from November, 1957, to April, 1958, and the areas then planted are now in plucking.

Plucking.—This was begun towards the end of 1957 on the area planted in April, 1956, and the whole area came into plucking by the middle of 1958. Detailed records of green leaf obtained were kept for the whole of 1959 (Table 1).

TABLE 1.—*Monthly yields of green leaf in* 1959 *from* 36½ *perches of TRI* 2026 *planted April-September*, 1956

	lb.		lb.
January	166	July	351
February	185	August	209
March	200	September	348
April	337	October	385
May	322	November	544
June	456	December	314
	1,666		2,151
			1,666
			3,817

On the basis of 36½ perches (including drains), this works out at about 16,600 lb. of green leaf per acre per annum; at 23% out-turn, this is about 3,850 lb. of made tea per acre per annum at around three years after the cuttings were planted.

The plucking has not been hard; two experienced planters of Deniyaya (Mr R. L. Perera and Mr G. Thambipillai) have expressed the opinion that 10–15% more crop could be obtained without detriment to the bushes.

During the same period, I have also planted TRI 2023; growth appears to be as good and as fast as that of TRI 2026, but I have not test-plucked it.

It is a pleasure to thank Mr F. H. Kehl for his guidance and advice.

D. S. Jayawickrama.

Sylverine, Matara,
6th January, 1960.

SUMMARY MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT ST. COOMBS, TALAWAKELE, ON FRIDAY, 4TH MARCH, 1960, AT 9.30 A.M.

———————

Present:—Messrs F. Amarasuriya (Chairman), G. I. de Glanville (Chairman. Agency Section, Planters' Association of Ceylon), H. Creighton (Chairman, Planters' Association of Ceylon), C. Selwyn Samaraweera (Chairman, Low-Country Products Association of Ceylon), B. Mahadeva, C.C.S. (Tea Controller), R. C. Scott, C.B.E., J. L. D. Peiris, R. M. Macintyre, R. J. Gilmour, R. D. Wedd, W. H. W. Coultas, E. Jayawickreme, D. E. Hettiarachchi, N. M. Sanders, Dr D. L. Gunn, C.B.E. (Director, T.R.I.), Messrs G. A. D. Kehl (Administrative Secretary, T.R.I.) and H. J. Balmond (Secretary, Board of Control, T.R.I.)

Messrs H. E. Peiris, O.B.E., C.C.S., Dr M. F. Chandraratna, M.B.E. and Senator Reginald Perera intimated their inability to be present.

The Chairman announced that arrangements had been made for members of the Board to see the Stage I Pilot Plant (Instant Tea) at work in the factory from 11-30 a.m. when he hoped the meeting would have ended.

1. Minutes of the Meeting of the Board held on 4th December, 1959

The minutes of the meeting of the Board held on 4th December, 1959, were confirmed subject to the following corrections (*vide* Circular B.2/60):—

(1) Present.—Add the name of Mr H. Creighton (Chairman, Planters' Association of Ceylon).

(2) Resolution for the use of the Board's Seal.—*Delete* lines 1 and 2 of paragraph (*a*), *i.e.* "Mr J. L. D. Peiris proposed.....on the following documents." and *Substitute*:—"It was reported that the Board's Seal had been affixed to:—

2. Matters Arising from the Meetings

The Board received the following reports:—

(1) Scientific Advisory Committee in the United Kingdom.—Sir Joseph Hutchinson was unable to serve on the committee and Professor G. E. Blackman, F.R.S., would serve on the committee instead. The Chairman, Ceylon Association in London, had been invited to attend meetings of the committee. The first meeting was held on 24th February, 1960.

(2) Plant Breeder.—Applications for the post of Plant Breeder would close on 31-3-60. Two firm applications had so far been received.

(3) **Instant Tea.**—Replies had been received from the Ministries of Industries and Fisheries, and Commerce and Trade. The Ministry of Industries and Fisheries stated that the Government had granted no monopoly nor had agreed to any conditions which would hamper the exploitation of any other process. The question as to whether the "Ceytea" process would receive the same concessions would be considered on receipt of concrete proposals.

The Ministry of Commerce and Trade had replied that it would be possible to consider the same concessions as granted to a similar project (*vide* their letter No. P.R. 313 of 23rd October, 1958) in respect of the "Ceytea" process, but regretted, however, that no definite undertaking could be given at present.

The Director said that some of the concessions could not apply to the Tea Research Institute which already imported equipment and machinery for research purposes free of duty, and which was already exempt from income tax.

(4) **Dr F. R. Tubbs.**—Dr Tubbs was expected to be in Ceylon for the month of July and possibly some part of June and August.

(5) **Mid-country clonal-testing station, Hantane Estate, Kandy.**—Work on the selected site had been started. The lease proposals from Messrs George Steuart & Company were awaited.

3. **Membership of the Board and Committees**

Experimental and Estate Committee.—Reported that Mr C. R. Burnett had been nominated to take the place of Mr J. E. Davidson who resigned as from 7-2-60.

Mr H. D. Ross had been nominated to act for Mr A. Watt during his absence on leave.

The report was received. The Chairman thanked the outgoing members for their services and welcomed the new members.

4. **Minutes of the Meeting of the Administrative Committee held on 13th February (Paper S.C. 18/60)**

The minutes of the Administrative Committee held on 13-2-60 which had been circulated to the Board (Paper S.C. 18/60) were tabled for discussion and adoption.

(1) **Provident Fund & Dearness Allowances (Paper S.C. 6/60).**—The Director said that after a full discussion this matter had been referred to the anomalies sub-committee for further detailed investigation and report. He suggested that the sub-committee be extended to include Mr H. E. Peries, Secretary to the Treasury, and a representative selected by the Planters' Association of Ceylon. The sub-committee was scheduled to meet that afternoon for preliminary discussions.

Mr Macintyre said that fundamental principles were involved in the proposals which would have vital repercussions throughout the tea industry and in the other two Institutes. He could not entirely agree with the Director's basis of calculation for Provident Fund benefits to the Staff. Nor had he heard of such a calculation being adopted elsewhere. The proposals seem to have ignored the important element of interest earned on the investment of total contributions to meet the interest payable on employee contributions. Besides, some of the facts as recorded in the minutes were inaccurate. The Estates' Staff Provident Society was not the only scheme that should be considered. There were other schemes and he felt

that, in view of the widespread implications of the proposals, a decision should first be made as to whether there was a case for increasing the target figures of the individuals, assuming there would be an increase.

Mr Mahadeva suggested that, as the Anomalies Committee had completed its work, a new *ad hoc* sub-committee, the Provident Fund Committee, be appointed to report on these proposals.

Mr Gilmour wished to know whether any other members of the Board had any definite views on the proposals which the proposed sub-committee should take into consideration during their deliberations.

Mr Coultas said that there was a very strong case for revising the existing Provident Fund rates. Requests for *ex-gratia* payments in addition to normal Provident Fund benefits had already been discussed and sanctioned. He quoted the recent case of the hostel keeper, who, after 10 years' service, had only about Rs. 800/- in his Provident Fund, and it seemed very necessary that the whole question of Provident Fund benefits should be reviewed by a sub-committee whose report could be submitted to the Board for discussion.

Mr R. C. Scott agreed with Mr Coultas.

Mr de Glanville said that he hoped the committee would not take unilateral action in this matter without consulting other interested bodies.

The Director said that the sub-committee could only make recommendations to the Board and such recommendations would be made after consultation with the other Institutes.

Mr Sanders asked whether it was correct that there was a tendency in other sectors to consider favourably the payment of Provident Fund benefits on Dearness Allowance.

Mr Gilmour replied that it was very difficult to make a definite statement on the matter. A number of agency houses did so in the case of executive staff. In the National Provident Fund, contributions were made on total earnings. He was of opinion that Provident Fund should be related to present earnings and total earnings and it was rather illogical to calculate such benefits on what was known were not total earnings. To consider that a Dearness Allowance was a temporary feature was a fiction.

After further discussion the Board referred the matter to a committee consisting of Mr F. Amarasuriya (Chairman), Mr G. I. de Glanville (Chairman, Agency Section, P.A.), Mr H. E. Peries (Deputy Secretary to the Treasury), Mr B. Mahadeva, Mr R. J. Gilmour, Mr R. D. Wedd, Mr W. H. W. Coultas, Dr D. L. Gunn (Director) *ex-officio* and a representative selected by the Planters' Association, for further examination and report.

(2) Low-country sub-station.—Mr J. L. D. Peiris proposed that one of the two valuers to be appointed to value the estate bought for the low-country sub-station should be a recognised valuer with wide experience in valuation of lands.

The Board agreed that one of the valuers should be a recognised valuer with experience in land valuation.

The Board also agreed that, before valuation of a selected estate was agreed upon, the Institute's architects make an inspection as to whether there are adequate building sites available for research officers and staff on the proposed set-up and for an expanded scheme for the future.

The Director said that the Agency Houses had been asked to inform the Institute of any estates that were likely to be available. In the meantime five enquiries had been received in reply to the Press advertisement and these were being examined by Dr Joachim.

(3) Estate Staff: Recommendation for payment of bonus. (Paper No. S.C. 11/60). In reply to a question from Mr Macintyre, the Director said that the payment of bonus to estate staff was a matter for the recommendation of the Experimental and Estate Committee and it has accordingly been referred back to that committee.

(4) Supplementary Estimates. ELECTRIFICATION.—Mr Gilmour asked for information regarding the proposed electrification of the Institute.

Mr Coultas said that the report was being considered by the Visiting Agent, and by the Chief Resident Engineer of the Government Hydro-Electric Scheme, and it appeared that the Institute would have to decide between a direct supply and complete replacement of existing engines and equipment.

The Director said that the report would be tabled for discussion at the next meeting of the Board.

KOTTAWA V.P. TESTING STATION: SUPPLEMENTARY ESTIMATE Rs. 100,000/-.—The Director said that the original estimate of Rs. 85,000/- had been increased to Rs. 100,000/- on the recommendation of the low-country committee.

The Director said that other sub-stations were situated within estates while this site was on Crown land and capital costs in respect of roads and bridges, etc. were high. Building costs in the low-country were much lower than in the up-country. After discussion the estimate was approved.

O. J. FERNANDO, CLERK OF WORKS: PAYMENT OF OVERTIME ALLOWANCE. (PAPER S.C. 17/60).—In reply to Mr Creighton the Chief Administrative Officer stated that a commuted allowance had been recommended because the extra hours of work were unsupervised and within the discretion of the officer concerned. Agreed that this allowance would cease when the building projects were completed.

(5) Additional Supplementary Estimates and Revotes.—The Director reported that since the last meeting of the Administrative Committee he had received further requests for supplementary expenditure and the Board's approval of this expenditure was required. The supplementary estimates were:—

(*a*) ENTOMOLOGY—SPECIAL RESEARCH.—Rs. 3,200/- for the purchase of 10 Mars Knapsack sprayers with accessories to enable Dr Judenko to expand the areas sprayed within one day. The Board approved the supplementary expenditure.

(*b*) NEMATOLOGY.—Rs. 1,500/- for construction of a store-house at Nursery No. 12, one of the eelworm nurseries. As the experiment would be spread over a number of years, a permanent building was necessary. The Board approved the supplementary expenditure.

(*c*) LOW-COUNTRY MANUFACTURE.—Rs. 50,000/- was required for the purchase of experimental machinery for the low-country as follows:—

2 experimental rollers at Rs. 10,000/- each ...	Rs. 20,000.00
1 roll-breaker to match	„ 3,000.00
2 driers (with boiler) to match	„ 17,000.00
Motors, fittings and contingencies	„ 10,000.00
	Rs. 50,000.00

In view of normal delays in the making and importation of machinery it was important that the orders should be placed now. The Board approved the supplementary expenditure.

Mr Coultas made a special plea for fitting one of these rollers with a plastic jacket.

(*d*) Replanting programme: New Nursery. (Paper S.C. 1/60) Rs. 2,246.98 (Revote).—The Board approved a revote of Rs. 2,246.98 from the estimate of Rs. 4,728.50 approved for expenditure in 1959.

(*e*) Quality testing of tea bushes.—A vote of Rs. 10,000/- had been recommended by the Experimental and Estate Committee to meet the cost of quality testing of individual tea bushes. (Minute 9.2 of the Experimental and Estate Committee minutes (Paper B. 7/60).

The Board did not approve the arrangements made for tasting and referred this part of the estimate back to the Experimental and Estate Committee for further report. The remainder of the estimate was approved.

(6) **Experimental machinery from Russia.**—Mr Mahadeva said that when a delegation from the Institute had visited Russia, it had been suggested that one of the green-leaf sorting machines and a withering machine should be bought by the Institute for experimental purposes. He had since been informed that, owing to prohibitive costs, the matter had been dropped. He wished to know whether the Experimental and Estate Committee had considered this matter.

Mr Coultas said the Experimental and Estate Committee had considered the question and had not pursued the matter further owing to high costs.

Mr Mahadeva proposed that the question of importing this machinery be referred back to the Experimental and Estate Committee with the recommendation that, if the costs are prohibitive, the machinery be obtained under one of the Technical Assistance Schemes without cost to the Institute. The Board agreed.

(7) **The Building Programme— Development plans (Papers S.C. 8/60, S.C. 15/60 and B.C. 5/60).**—The Director said that the Development plans (Paper S.C. 8/60) had been considered by the Administrative Committee and at the request of the committee the phasing of the proposed building programme had been prepared in consultation with the Architects (Paper B.C. 5/60).

Mr Macintyre then proposed, seconded by Mr Mahadeva, that the proposed development plans be adopted. The Board approved the motion unanimously.

After full discussion Mr Gilmour proposed, seconded by Mr Mahadeva, that the Board record its appreciation and thanks for the valuable services rendered by Mr Coultas to the progress of the building programme. The Board unanimously approved the motion.

Increase in Cess.—The Chairman said that in order to implement these development plans an application should be made for an immediate increase of the cess from 55 cents to 75 cents per 100 lb. of tea exported.

Mr Gilmour asked whether in view of the heavy commitments involved an increase of 20 cents would be sufficient. He felt that the present reserves would not have been accumulated had the increase in cess at that time been related to only a limited expenditure and it was better to ask for more now, so that there would be always a reserve for marginal expenditure. He would wish to hear the views of the Board on the matter.

The Director said the figures in S.C. 15/60 were based on current estimates on a cess of 55 cents, and he would ask the Board, if it was willing, to recommend an application for an increase of cess of not less than 20 cents to meet immediate needs and to delegate to a group of persons the consideration of further increase.

Mr Macintyre said that when the Board accepted the recommendation of the Co-ordinating Committee for an increase of cess by 20 cents it took into consideration the actual expenditure envisaged in expanding staff, providing housing, etc., and the estimate of a 20 cents increase was based on estimated figures for both capital and recurrent expenditure.

Mr Mahadeva said that the estimated increase of 20 cents was based on foreseeable, estimated figures at that time but, since then, building costs had risen, a general increase in salaries was due in the Government sector with a consequent increase in the salaries of the Institute, there were proposals for additional Provident Fund benefits and all these factors would raise estimates. He accordingly thought it would be wiser to ask for an immediate increase of 25 to 30 cents.

Mr Wedd indicated that at the time the recommendation for an increase of 20 cents was made, the reserve had not been built up as it was today.

Mr Mahadeva replied that when the increase was recommended there were reserves and these were taken into consideration.

Mr Coultas suggested that a statement be prepared giving details of revenue expenditure when the full anticipated complement of staff was employed together with details of recurrent capital expenditure.

Mr Wedd said that any increase above 20 cents would necessitate consultation with the various bodies concerned to obtain their approval.

Mr Macintyre emphasised that it would not be wise to make a request for a further increase soon after the cess was raised by 20 cents, and he proposed that the Board approve in principle a higher rate of increase and that the Institute proceed to obtain the immediate increase of 20 cents. In the meantime the office could prepare the necessary figures for the consideration of the Administrative Committee and, if they considered the proposed increase inadequate to meet current and anticipated expenditure, the need for further increase could be put to the various bodies again.

The Director asked whether the Board would now agree to an increase of 20 cents. He would then study the needs of the more distant future and report to the Administrative Committee.

The Board agreed unanimously that an application be made to the Government for an immediate increase of cess from 55 cents to 75 cents per 100 lb. of tea exported and further directed that the necessary figures be prepared for the Administrative Committee to consider and report as to whether a further increase in cess would be necessary.

Amendments to the Ordinance.—Mr Mahadeva said that as an increase in cess required an amendment to the Principal Ordinance would it not be possible to include any other amendments that would be necessary. Apart from a consolidation of the Ordinance he had in mind a general revision of the Act which, for instance, could provide for a reduction in the membership of the Board with the same interests represented proportionately. The Board would be smaller and it could do away with the Administrative Committee. All this required careful

thought, and he asked whether it would not be worth while for the Director to give the suggestion close study and take up the matter separately or at the same time with the Government.

The Director thought it would be unwise to ask for any general revision of the Act as it was possible that amendments the Board did not want might be incorporated.

Mr Macintyre felt that it was not a good thing from the Industry's point of view to alter the composition of the Board by reduction.

Mr Coultas agreed with Mr Macintyre and said that the present set up had worked smoothly in the past few years.

The Director suggested that as the question of a general revision of the Act had been raised, the members might discuss this matter informally with their parent Associations so that, when the matter was next discussed at the Board, more mature and considered opinion could be brought to bear on the subject. The Board agreed.

(8) **Library.**—The Director said that Mr Blok, the University Librarian, had submitted a very useful report on the Institute Library and the Administrative Committee had accepted all the recommendations in the report except the recommendation for training a Librarian abroad, which had been referred to the Board for a decision. He added that a library was vitally important to a scientific worker, and the organization and efficient service in a library depended on a well-trained Librarian.

Mr Scott thought that Mr Blok would be able to recommend a suitable graduate.

The Director said he proposed to advertise the post after the final degree examinations and before the results were published.

Mr Gilmour asked whether any Ceylonese now being trained in the U.K. would be available and suggested that the High Commissioner for Ceylon in the U.K. be asked to assist.

The Director said he would give the advertisement a wide circulation.

Mr Mahadeva suggested that early arrangements be made to obtain a place at the University of London for the selected candidate.

The Board accordingly approved the recommendations in the report that the candidate selected for the post of Librarian be sent to the United Kingdom for training in Librarianship.

(9) **Institute's Insurances.**—The present distribution of the Institute's Insurance was discussed.

The Board decided that as it was the Board's intention that the Institute's Fire Insurances should be distributed equally among the Colombo Assurance, the Ceylon Insurance and the Mahajana Insurance Companies, the Colombo Assurance Company should be requested to distribute the Institute's fire insurances equally with the Ceylon Insurance and Mahajana Insurance Companies.

Mr Gilmour suggested that the question of insurances for next year be considered by the Administrative Committee and the Board before the next premiums were due. **Agreed.**

The Board then approved the minutes of the Administrative Committee held on 13-2-60 subject to the amendments made by the Board.

5. **Minutes of the Meetings of the Low-Country Sub-Station Committee held on 16-1-60 (Paper B. 4/60) and 12-2-60 (Paper B. 9/60)**

The minutes were approved.

6. **Minutes of the Meeting of the Experimental and Estate Committee held on 6-2-60 (Paper B. 7/60)**

The Director stated that he would like to raise the general subject of development of manufacture. He did not intend making at this stage any further proposals other than those recommended by the Experimental and Estate Committee, but he would like to have the opinion of the Board on the development of manufacture. He had already put up the subject to SACUK and he wished to know how far the Board was prepared to go in financing research in this direction.

The total staff concerned with manufacture consisted of the Technologist, a Research Assistant, due to go overseas for post-graduate work in Chemical Engineering, and two non-graduate Technical Assistants, one of whom should strictly be in the low country. Thus a very small proportion of the Institute's staff was concerned with manufacture while a much larger proportion was concerned with the production of the leaf. Was the Institute paying sufficient attention to manufacture? The Technologist devoted much of his time to advisory work and this was most important to the Industry; shortly he would be involved in investigations into drum withering, instant tea, selection of bushes for clonal lines, etc. These important investigations would inevitably be neglected if the advisory work was to continue without interruption. The recruitment of a Development Engineer would not solve the problem. One possibility was a new and separate division, headed by a Biochemist with practical industrial experience and high academic ability, with a Development Engineer under him. This would cost money and the question was how quickly does the industry want to proceed with the development of manufacture and he would like the views of the Board on the subject.

Mr Scott asked whether by development of manufacture it was meant a redesigning of machinery for more economical manufacture or investigation into the process of manufacture itself.

The Director said that he was referring in the first instance to the processes of conventional manufacture; but there was also plenty of work to be done on drum withering and instant tea. If the Institute obtained the right team they would be thinking on both conventional and original lines and there would then be a prospect of completely new developments.

The Director referring to an article in the latest *Tea Quarterly*, said that 100 drums were in use in East Africa and that the drum withering was being used in the low-country. His intention was to experiment on drum withering in the high country.

Mr Coultas said he doubted very much whether there was any industry in the world which had not changed its method of manufacture over 60 years. On the agricultural side, tremendous advances were being made but manufacture was more or less static.

The Director said it was perhaps inaccurate to say that nothing had been done. The position was that nothing revolutionary had been done.

Mr Coultas asked what benefits would result from Mr Ramaswamy's highly involved research into tea constituents.

The Director said that in research one had to probe and probe until one got something. At the same time the Institute had to have on the spot a man who knew a great deal about the biochemistry of tea.

Mr Macintyre said that in his mind there were two aspects to the problem — one, the development of the manufacture of the conventional product which is acceptable to the consumer public and the other, the development of a new form of product such as instant tea. He felt that the subject should be investigated by a committee which should include a representative of the Tea Propaganda Board, and one or two Tea Exporters with knowledge of consumer needs.

The Director said that an economic committee on tea manufacture appointed by the Board, with the right to co-opt experts, would meet the proposal of Mr Macintyre.

Mr Mahadeva said that the discussion indicated that the development of manufacture would relate to two separate and parallel lines of research, namely, research into the development of better and more economical manufacture of the conventional product through improvements in machinery and, secondly, research into the development of new types of tea such as instant tea. Everybody seemed generally agreed that research on the manufacture of the conventional product should be stressed but some doubts had been expressed as to the desirability of research into the manufacture of new types of tea and he felt that a decision should be made regarding the research objectives of the proposed development division.

Mr Wedd said that research both in conventional manufacture and in the manufacture of new types of tea should be conducted simultaneously on parallel lines.

After further discussion Mr R. C. Scott proposed, seconded by Mr Coultas, that the Board accept the principle of establishing a development division with a Biochemist in charge. The Board unanimously approved the motion.

The Board also directed that a memorandum on the proposed development division including some idea of costs be submitted as soon as possible.

7. Other Business

(1) Appointments Committee: Post of Plant Breeder.—The Board decided that in case Dr Chandraratna could not be present at the interview of Mr Green, the Director should invite Dr S. T. Senewiratne of the University to assist the committee.

(2) **Board Meetings at St. Coombs.**—Mr Gilmour suggested that when Board meetings were held at St. Coombs arrangements should be made for members to visit the factory, the estate, etc. and that the agenda should not be too long.

The Director said that this depended on how members treated the agenda. He would, however, be happy to make such arrangements.

Sgd. H. J. BALMOND,
Secretary, Board of Control.

Printed for the TEA RESEARCH INSTITUTE OF CEYLON *St. Coombs, Talawakelle, by* H. W. CAVE & CO., LTD., *Fort, Colombo.*